

NEW MADRID PUMPING STATION

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DIVISION 1 - GENERAL REQUIREMENTS

SECTION 01025

MEASUREMENT AND PAYMENT

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SECTION 01025

MEASUREMENT AND PAYMENT

PART 1 GENERAL

1.1 LUMP SUM PAYMENT

Payment items for the work of this contract for which contract lump sum payments will be made are listed in the BIDDING SCHEDULE according to CSI Specification Divisions and are described below. All costs for items of work, which are not specifically mentioned to be included in the listed lump sum item, shall be included in the listed lump sum item under the specification division which is most closely associated with the work involved. The lump sum price and payment made for each item listed shall constitute full compensation for furnishing all plant, labor, materials, and equipment, and performing any associated Contractor quality control, environmental protection, meeting safety requirements, tests and reports, and for performing all work required for which separate payment is not otherwise provided.

(1) "Mobilization and Demobilization"

- a. Payment will be made for costs associated with mobilization and demobilization, as defined in Section 00800 SPECIAL CONTRACT REQUIREMENTS paragraph 1.29 PAYMENT FOR MOBILIZATION AND DEMOBILIZATION. Separate payment will not be made for providing the other items described in Section 00800 SPECIAL CONTRACT REQUIREMENTS and all costs associated therewith shall be included in the applicable lump sum prices contained in the bidding schedule.
- b. Unit of Measure: Lump Sum (LS).

(2) "Environmental Protection"

- a. Payment will be made for the costs associated with operations necessary for environmental protection as specified in Section 01130 ENVIRONMENTAL PROTECTION. Separate payment will not be made for providing signs, barricades, and traffic control outlined in Section 01450 PROJECT SIGNS, BARRICADES, AND TRAFFIC CONTROL for providing and maintaining the submittal procedures outlined in SECTION 01330 SUBMITTAL PROCEDURES, or in providing and maintaining an effective quality control program as outlined in Section 01451 CONTRACTOR QUALITY CONTROL, and all costs associated therewith shall be included in the applicable lump sum prices contained in the bidding schedule.
- b. Unit of Measure: Lump Sum (LS).

(3) "Sitework"

- a. Payment will be made for clearing and grubbing, embankment; semi-compacted (includes closure levee, cofferdam, and channel closures, front line levee enlargement, diversion channel refill); embankment; uncompacted (includes land side

seepage berm, low water dikes, cofferdam channel closures), dewatering, excavation (includes conversion channel, inlet and outlet channel improvements), structural excavation, muck excavation, dewatering, pervious backfill, impervious backfill (includes clay blanket), MSE retaining walls, vibro-flotation densification, riprap R200, riprap R650, filter stone, filter fabric, asphalt surfacing, gravel surfacing, surface drainage system (includes manholes, lined cylinder pipe, pipe bedding, and backfill), wall drainage system (includes collector pipes, filter gravel, filter fabric, check valves, cleanouts, manholes), sheet piling, waterwell, piezometers, staff gauges, conduits, seeding and fertilizing, and all sitework defined in DIVISION 2 SITEWORK or included on the drawings which have not been previously mentioned.

- b. Unit of Measure: Lump Sum (LS).

(4) “Concrete”

- a. Payment for concrete shall be all concrete, reinforcing steel, waterstops, forms, finishes and curing for all cast-in-place concrete on the project which includes concrete pads, scour pads, gutters, stilling basin and retaining walls, gate tower, walkway, conduits, pump station (includes slabs, walls, and superstructure) wall drain manholes and vaults, and any other concrete and reinforcing defined in DIVISION 3 CONCRETE or included on the drawings which have not been previously mentioned.

- b. Unit of Measure: Lump Sum (LS).

(5) “Masonry”

- a. Payment for masonry shall include all interior and exterior concrete masonry units, masonry accessories, mortar, and any other masonry defined in DIVISION 4 MASONRY or included on the drawings which have not been previously mentioned.

- b. Unit of Measure Lump Sum (LS).

(6) “Metals”

- a. Payment for metals includes all structural steel, embedded steel, miscellaneous metals, sluice gates, grating, handrails, hatches, stoplogs and any other metal or steel items defined in DIVISION 5 METALS or included on the drawings which have not been previously mentioned.

- b. Unit of Measure: Lump Sum (LS).

(7) “Wood and Plastic”

- a. Payment for wood and plastic includes all millwork and any other wood and plastic items defined in DIVISION 6 WOOD AND PLASTIC or included on the drawings which have not been previously mentioned.

- b. Unit of Measure: Lump Sum (LS).

(8) “Thermal and Moisture Protection”

- a. Payment for thermal and moisture protection includes all roofing, roof and wall flashing, insulation, wood nailers and cants, joint sealants, sheet metal, roof hatches and any other items defined in DIVISION 7 THERMAL AND MOISTURE PROTECTION or included on the drawings that have not been previously mentioned.
- b. Unit of Measure: Lump Sum (LS).

(9) “Doors and Windows”

- a. Payment for doors and windows includes all doors (interior, exterior and overhead), frames, windows, glazing, hardware and any other items defined in DIVISION 8 DOORS AND WINDOWS or included on the drawings which have not been previously mentioned.
- b. Unit of Measure: Lump Sum (LS).

(10) “Finishes”

- a. Payment for finishes includes acoustical ceilings, flooring, painting and all other items defined in DIVISION 9 FINISHES or included on the drawings that have not been previously mentioned.
- b. Unit of Measure: Lump Sum (LS).

(11) “Specialties”

- a. Payment for specialties shall be all interior and exterior signage, toilet room accessories, and any other items defined in DIVISION 10 SPECIALTIES or included on the drawings that have not been previously mentioned.
- b. Unit of Measure: Lump Sum (LS).

(12) “Equipment”

- a. Payment for equipment shall be for the speed reducer for the storm water pumps, trash rakes and all associated equipment defined in DIVISION 11 EQUIPMENT or included on the drawings which have not been previously mentioned.
- b. Unit of Measure: Lump Sum (LS).

(13) “Furnishings”

- a. Payment for furnishings includes cabinets, countertops, hardware and any other item defined in DIVISION 12 FURNISHINGS or included on the drawings which have not been previously mentioned.
- b. Unit of Measure: Lump Sum (LS).

(14) "Conveying Systems"

- a. Payment for conveying systems includes the overhead electric crane and all associated equipment defined in DIVISION 14 CONVEYING SYSTEMS and shown on the drawings.
- b. Unit of Measure: Lump Sum (LS).

(15) "Mechanical"

- a. Payment for mechanical includes all pumps, electric motors, thermal insulation for mechanical systems, plumbing, air supply distribution, ventilation, exhaust system, water system, wastewater disposal and any other items defined in DIVISION 15 MECHANICAL or included on the drawings that have not been previously mentioned.
- b. Unit of Measure: Lump Sum (LS).

(16) "Electrical"

- a. Payment for electrical includes all motor control centers, medium voltage electrical systems, interior electrical work, coordinating power system protection, lightning protection system, and all other electrical controls and systems defined in DIVISION 16 ELECTRICAL or included on the drawings that have not been previously mentioned.
- b. Unit of Measure: Lump Sum (LS).

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

End of Section

DIVISION 1 - GENERAL REQUIREMENTS

SECTION 01090

SOURCES FOR REFERENCE PUBLICATIONS

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SECTION 01090

SOURCES FOR REFERENCE PUBLICATIONS

1.1 REFERENCES

Various publications are referenced in other sections of the specifications to establish requirements for the work. These references are identified in each section by document number, date and title. The document number used in the citation is the number assigned by the sponsoring organization, e.g. UL 1 (1993; Rev thru Jan 1995) Flexible Metal Conduit. However, when the sponsoring organization has not assigned a number to a document, an identifying number has been assigned for convenience, e.g. UL's unnumbered 1995 edition of their Building Materials Directory is identified as UL-01 (1995) Building Materials Directory. The sponsoring organization number (UL 1) can be distinguished from an assigned identifying number (UL-01) by the lack of a dash mark (-) in the sponsoring organization assigned number.

1.2 ORDERING INFORMATION

The addresses of the organizations whose publications are referenced in other sections of these specifications are listed below, and if the source of the publications is different from the address of the sponsoring organization, that information is also provided. Documents listed in the specifications with numbers which were not assigned by the sponsoring organization should be ordered from the source by title rather than by number.

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Seed Regulatory and Testing Branch
USDA, AMS, LS Div.
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Fax: 301-504-5454 Internet: <http://www.ams.usda.gov/lsg/lb-sd.htm>
e-mail: james_p_triplett@usda.gov

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Fax: 312-201-0214

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TRUSS PLATE INSTITUTE (TPI)
583 D'Onofrio Dr., Suite 200
Madison, WI 53719
Ph: 608-833-5900
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TUBULAR EXCHANGE MANUFACTURERS ASSOCIATION (TEMA)
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Tarrytown, NY 10591
Ph: 914-332-0040
Fax: 914-332-1541

UNDERWRITERS LABORATORIES (UL)

333 Pfingsten Rd.
Northbrook, IL 60062-2096
Ph: 800-704-4050
Fax: 847-509-6249
Internet: <http://www.ul.com/>
Order from:
Global Engineering Documents
15 Inverness Way East
Englewood, CO 80112-5776
Ph: 800-569-7128
Fax: 303-397-7945
Internet: <http://global.ihs.com>
E-mail: global@ihs.com

UNI-BELL PVC PIPE ASSOCIATION (UBPPA)

2655 Villa Creek Dr., Suite 155
Dallas, TX 75234
Ph: 214-243-3902
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WATER QUALITY ASSOCIATION (WQA)

4151 Naperville Rd.
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Ph: 630-505-0160
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WEST COAST LUMBER INSPECTION BUREAU (WCLIB)

P.O. Box 23145
Portland, OR 97281
Ph: 503-639-0651
Fax: 503-684-8928

WESTERN WOOD PRESERVERS INSTITUTE (WWPI)

601 Main Street
Suite 405
Vancouver, WA 98660 Ph: 360-693-9958
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WESTERN WOOD PRODUCTS ASSOCIATION (WWPA)

Yeon Bldg.
522 SW 5th Ave.
Portland, OR 97204-2122
Ph: 503-224-3930
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WOOD MOULDING AND MILLWORK PRODUCERS ASSOCIATION (WMMPA)
507 First Street
Woodland, CA 95695
Ph: 916-661-9591
Fax: 916-661-9586

End of Section

DIVISION 1 - GENERAL REQUIREMENTS

SECTION 01130

ENVIRONMENTAL PROTECTION

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SECTION 01130

ENVIRONMENTAL PROTECTION

PART 1 GENERAL

1.1 DEFINITIONS

For the purpose of this specification, environmental pollution and damage is defined as the presence of chemical, physical, or biological elements or agents which adversely affect human health or welfare; unfavorably alter ecological balances of importance to human life; affect other species of importance to man; or degrade the utility of the environment for aesthetic, cultural and/or historical purposes. The control of environmental pollution and damage requires consideration of air, water, and land, and includes management of visual aesthetics, noise, solid waste, radiant energy and radioactive materials, as well as other pollutants.

1.2 ENVIRONMENTAL PROTECTION REQUIREMENTS

Provide and maintain, during the life of the contract, environmental protection. Plan for and provide environmental protective measures to control pollution that develops during normal construction practice. Plan for and provide environmental protective measures required to correct conditions that develop during the construction of permanent or temporary environmental features associated with the project. Comply with Federal, State, and local regulations pertaining to the environment, including but not limited to water, air, and noise pollution.

1.2.1 Environmental Protection Plan

Within 21 days after receipt of Notice of Award of the contract, the Contractor shall submit in writing an Environmental Protection Plan and, prior to starting work, and meet with representatives of the Contracting Officer to develop mutual understanding relative to compliance with this provision and administration of the environmental protection program. Approval of the Contractor's plan will not relieve the Contractor of his responsibility for adequate and continuing control of pollutants and other environmental protection measures. The Government reserves the right to make changes in his environmental protection plan and operations as necessary to maintain satisfactory environmental protection performance. The Environmental Protection Plan shall include but not be limited to the following:

1.2.1.1 Protection of Features

The Contractor shall determine methods for the protection of features to be preserved within authorized work areas. The Contractor shall prepare a listing of methods to protect resources needing protection, i.e., trees, shrubs, vines, grasses and ground cover, landscape features, air and water quality, fish and wildlife, soil, historical, archaeological and cultural resources.

1.2.1.2 Procedures

The Contractor shall implement procedures to provide the required environmental protection and to comply with the applicable laws and regulations. The Contractor shall set out the procedures to be

followed to correct pollution of the environment due to accident, natural causes or failure to follow the procedures set out in accordance with the Environmental Protection Plan.

1.2.1.3 Permit or License

The Contractor shall obtain all needed permits or licenses which have not been obtained by Corps of Engineers. These may include, but are not limited to building permits, burn permits, waste disposal permits and other licenses or permits required by local officials.

1.2.1.4 Drawings

The Contractor shall include drawings showing locations of any proposed temporary excavations or embankments for haul roads, stream crossings, material storage areas, structures, sanitary facilities, stockpiles of earth materials, and disposal areas for excess earth material and unsatisfactory earth materials.

1.2.1.5 Environmental Monitoring Plans

The Contractor shall include environmental monitoring plans for the jobsite which incorporate land, water, air and noise monitoring.

1.2.1.6 Traffic Control Plan

The Contractor shall include a traffic control plan for the job site.

1.2.1.7 Surface and Ground Water

The Contractor shall establish methods of protecting surface and ground water during construction activities.

1.2.1.8 Work Area Plan

The Contractor shall include a work area plan showing the proposed activity in each portion of the area and identifying the areas of limited use or nonuse. The plan shall include measures for marking the limits of use areas.

1.2.1.9 Plan of Borrow Area(s)

The Contractor shall include a plan of borrow area(s) for the job site.

1.3 SUBCONTRACTORS

Assurance of compliance with this section by subcontractors will be the responsibility of the Contractor.

1.4 PERMITS OBTAINED BY CORPS OF ENGINEERS

The Corps of Engineers is responsible for environmental handling, cultural clearance, water quality certification, 404 authorization and stormwater discharge (SWPPP).

1.5 REGULATORY REQUIREMENTS

The Contractor shall comply with all state regulatory and statutory requirements.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION

3.1 PROTECTION OF ENVIRONMENTAL RESOURCES

The environmental resources within the project boundaries and those affected outside the limits of permanent work under this contract shall be protected during the entire period of this contract. The Contractor shall confine his activities to areas defined by the contract drawings or specifications. Environmental protection shall be as stated in the following subparagraphs.

3.1.1 Protection of Land Resources

Prior to the beginning of any construction, the Contracting Officer will identify all land resources to be preserved within the Contractor's work area. The Contractor shall not remove, cut, deface, injure, or destroy land resources including trees, shrubs, vines, grasses, top soil, and land forms without special permission from the Contracting Officer. No ropes, cables, or guys shall be fastened to or attached to any trees for anchorage unless specifically authorized. Where such special emergency use is permitted, the Contractor shall provide effective protection for land and vegetation resources at all times as defined in the following subparagraphs.

3.1.1.1 Work Area Limits

Prior to any construction, the Contractor shall mark the areas where no work is to be performed under this contract. Isolated areas within the general work area which are to be saved and protected shall also be marked or fenced. Monuments and markers shall be protected before construction operations commence and during all construction operations. Where construction operations are to be conducted during darkness, the markers shall be visible during darkness. The Contractor shall convey to his personnel the purpose of marking and/or protection of all necessary objects.

3.1.1.2 Protection of Landscape

Trees, shrubs, vines, grasses, land forms and other landscape features to be preserved, indicated and defined on the drawings submitted by the Contractor as a part of the Environmental Protection Plan, shall be clearly identified by marking, fencing, or wrapping with boards, or any other approved techniques.

3.1.1.3 Reduction of Exposure of Unprotected Erodible Soils

Earthwork brought to final grade shall be finished as indicated and specified. Side slopes and back slopes shall be protected as soon as practicable upon completion of rough grading. All earthwork shall be planned and conducted to minimize the duration of exposure of unprotected soils. Except in instances where the constructed feature obscures borrow areas, quarries and waste material areas, these areas shall not initially be cleared in total. Clearing of such areas shall progress in reasonably sized increments as needed to use the areas developed as approved by the Contracting Officer.

3.1.1.4 Temporary Protection of Disturbed Areas

Such methods as necessary shall be utilized to effectively prevent erosion and control sedimentation, including but not limited to the following:

a. Retardation and Control of Runoff

Runoff from the construction site shall be controlled by construction of diversion ditches, benches, and berms to retard and divert runoff to protected drainage courses, and the Contractor shall also utilize any measures required by area-wide plans approved under Paragraph 208 of the Clean Water Act.

3.1.1.5 Erosion and Sedimentation Control Devices

The Contractor shall construct or install all temporary and permanent erosion sedimentation control features. Temporary erosion and sediment control measures such as berms, dikes, drains, sedimentation basin, grassing and mulching shall be maintained until permanent drainage and erosion control facilities are completed and operative.

3.1.1.6 Location of Contractor Facilities

The Contractor's field offices, staging areas, stockpiles, storage, and temporary buildings shall be placed in areas designated on the contract drawings and approved by the Contracting Officer. Temporary movement or relocation of Contractor facilities shall be made only on approval by the Contracting Officer.

3.1.1.7 Borrow Areas on Government Property

Borrow areas on Government property shall be managed to minimize erosion and to prevent sediment from entering nearby water courses or lakes.

3.1.1.8 Disposal Areas on Government Property

Disposal areas on Government property shall be managed and controlled to limit material to areas designated on the contract drawings and prevent erosion of soil or sediment from entering nearby water courses or lakes. Disposal areas shall be developed in accordance with the grading plan indicated on the contract drawings.

3.1.1.9 Temporary Excavation and Embankments

Temporary excavation and embankments shall be controlled to protect adjacent areas from contamination.

3.1.1.10 Disposal of Solid Wastes

Solid wastes (excluding clearing debris) shall be placed in containers which are emptied on a regular schedule. All handling and disposal shall be conducted to prevent contamination. The Contractor shall transport all solid waste off Government property and dispose of it in compliance with Federal, State, and local requirements for solid waste disposal.

3.1.1.11 Disposal of Chemical Wastes

Chemical wastes shall be stored in corrosion resistant containers, removed from the work area and disposed of in accordance with Federal, State, and local regulations.

3.1.1.12 Disposal of Discarded Materials

Discarded materials other than those which can be included in the solid waste category shall be handled as directed by the Contracting Officer.

3.2 HISTORICAL, ARCHAEOLOGICAL AND CULTURAL RESOURCES

Existing historical, archaeological and cultural resources within the Contractor's work area will be so designated by the Contracting Officer and precautions shall be taken by the Contractor to preserve all such resources as they existed at the time they were pointed out to the Contractor. The Contractor shall install all protection for these resources so designated on the contract drawings and shall be responsible for their preservation during this contract. If during construction items of apparent archaeological or historical interest are discovered, they shall be left undisturbed and the Contractor shall report the find immediately to the Contracting Officer.

3.3 PROTECTION OF WATER RESOURCES

The Contractor shall keep construction activities under surveillance, management and control to avoid pollution of surface and ground waters. Special management techniques as set out below shall be implemented to control water pollution by the listed construction activities which are included in this contract.

3.3.1 Cofferdam and Diversion Operations

The Contractor shall plan his operations and perform all work necessary to minimize adverse impact or violation of the water quality standard. Construction operations for dewatering, removal of cofferdams, tailrace excavation, and tunnel closure shall be controlled at all times to limit impact of water turbidity on the habitat for wildlife and impacts on water quality for downstream use.

3.3.2 Stream Crossings

Stream crossings shall be controlled during construction. Crossings shall provide movement of materials or equipment which do not violate water pollution control standards of the Federal, State or local government.

3.3.3 Monitoring of Water Areas Affected by Construction Activities

Monitoring of water areas affected by construction activities shall be the responsibility of the Contractor. All water areas affected by construction activities shall be monitored by the Contractor.

3.4 PROTECTION OF FISH AND WILDLIFE RESOURCES

The Contractor shall keep construction activities under surveillance, management and control to minimize interference with, disturbance to and damage of fish and wildlife. Species that require specific attention along with measures for their protection shall be listed by the Contractor prior to beginning of construction operations.

3.5 PROTECTION OF AIR RESOURCES

The Contractor shall keep construction activities under surveillance, management and control to minimize pollution of air resources. All activities, equipment, processes, and work operated or performed by the Contractor in accomplishing the specified construction shall be in strict accordance with the laws of the state or states in which the work is being done and all Federal emission and performance laws and standards. Special management techniques as set out below shall be implemented to control air pollution by the construction activities which are included in the contract.

3.5.1 Particulates

Dust particles, aerosols, gaseous by-products from all construction activities, processing and preparation of materials, such as from asphaltic batch plants, shall be controlled at all times, including weekends, holidays and hours when work is not in progress. The Contractor shall maintain all excavations, stockpiles, haul roads, permanent and temporary access roads, plant sites, spoil areas, borrow areas, and all other work areas within or outside the project boundaries free from particulate which would cause the air pollution standards mentioned in the paragraph PROTECTION OF AIR RESOURCES to be exceeded or which would cause a hazard or a nuisance. Sprinkling, chemical treatment of an approved type, light bituminous treatment, baghouse, scrubbers, electrostatic precipitators or other methods will be permitted to control particulates in the work area. Sprinkling, to be efficient, must be repeated at such intervals as to keep the disturbed area damp at all times. The Contractor must have sufficient competent equipment available to accomplish this task. Particulate control shall be performed as the work proceeds and whenever a particulate nuisance or hazard occurs.

3.5.2 Hydrocarbons and Carbon Monoxide

Hydrocarbons and carbon monoxide emissions from equipment shall be controlled to Federal and State allowable limits at all times

3.5.3 Odors

Odors shall be controlled at all times for all construction activities, processing and preparation of materials.

3.5.4 Monitoring Air Quality

Monitoring of air quality shall be the responsibility of the Contractor. All air areas affected by the construction activities shall be monitored by the Contractor.

3.6 INSPECTION

The Contracting Officer will notify the Contractor in writing of any observed noncompliance with the Contractor's environmental protection plan. The Contractor shall, after receipt of such notice, inform the Contracting Officer of proposed corrective action and take such action as may be approved. If the Contractor fails to comply promptly, the Contracting Officer may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No time extensions will be granted or costs or damages allowed to the Contractor for any such suspension.

3.7 POST CONSTRUCTION CLEANUP

The Contractor shall clean up all area(s) used for construction.

3.8 RESTORATION OF LANDSCAPE DAMAGE

The Contractor shall restore all landscape features damaged or destroyed during construction operations outside the limits of the approved work areas. Such restoration shall be in accordance with the plans submitted for approval by the Contracting Officer.

3.9 MAINTENANCE OF POLLUTION FACILITIES

The Contractor shall maintain all constructed facilities and temporary pollution control devices for the duration of the contract or for that length of time construction activities create the particular pollutant.

3.10 TRAINING OF CONTRACTOR PERSONNEL IN POLLUTION CONTROL

The Contractor shall train his personnel in all phases of environmental protection. The training shall include methods of detecting and avoiding pollution, familiarization with pollution standards, both statutory and contractual, and installation and care of facilities (vegetative covers and instruments required for monitoring purposes) to insure adequate and continuous environmental pollution control.

End of Section

DIVISION 1 - GENERAL REQUIREMENTS

SECTION 01330

SUBMITTAL PROCEDURES

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SECTION 01330

SUBMITTAL PROCEDURES

PART 1 GENERAL

1.1 SUBMITTAL IDENTIFICATION

SD-01 Data

SD-04 Drawings

SD-06 Instructions

SD-07 Schedules

SD-08 Statements

SD-09 Reports

SD-13 Certificates

SD-14 Samples

SD-18 Records

SD-19 Operation and Maintenance Manuals

1.2 SUBMITTAL CLASSIFICATION

Submittals are classified as follows:

1.2.1 Government Approved

Governmental approval is required for extensions of design, critical materials, deviations, equipment whose compatibility with the entire system must be checked, and other items as designated by the Contracting Officer. Within the terms of the Contract Clause entitled "Specifications and Drawings for Construction," they are considered to be "shop drawings."

1.2.2 Information Only

All submittals not requiring Government approval will be for information only. They are not considered to be "shop drawings" within the terms of the Contract Clause referred to above.

1.3 APPROVED SUBMITTALS

The Contracting Officer's approval of submittals shall not be construed as a complete check, but will indicate only that the general method of construction, materials, detailing and other information are satisfactory. Approval will not relieve the Contractor of the responsibility for any error which may exist, as the Contractor is responsible for dimensions, the design of adequate connections and details,

and the satisfactory construction of all work. After submittals have been approved by the Contracting Officer, no resubmittal for the purpose of substituting materials or equipment will be considered unless accompanied by an explanation of why a substitution is necessary.

1.4 DISAPPROVED SUBMITTALS

The Contractor shall make all corrections required by the Contracting Officer and promptly furnish a corrected submittal in the form and number of copies specified for the initial submittal. If the Contractor considers any correction indicated on the submittals to constitute a change to the contract, a notice in accordance with the Contract Clause "Changes" shall be given promptly to the Contracting Officer.

1.5 WITHHOLDING OF PAYMENT

Payment for materials incorporated in the work will not be made if required approvals have not been obtained.

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION

3.1 GENERAL

The Contractor shall make submittals as required by the specifications within 15 calendar days after receipt of notice to proceed. The Contracting Officer may request submittals in addition to those specified when deemed necessary to adequately describe the work covered in the respective sections. Units of weights and measures used on all submittals shall be the same as those used in the contract drawings. Each submittal shall be complete and in sufficient detail to allow ready determination of compliance with contract requirements. Prior to submittal, all items shall be checked and approved by the Contractor's Quality Control (CQC) representative and each item shall be stamped, signed, and dated by the CQC representative indicating action taken. Proposed deviations from the contract requirements shall be clearly identified. Submittals shall include items such as: Contractor's, manufacturer's, or fabricator's drawings; descriptive literature including (but not limited to) catalog cuts, diagrams, operating charts or curves; test reports; test cylinders; samples; O&M manuals (including parts list); certifications; warranties; and other such required submittals. Submittals requiring Government approval shall be scheduled and made prior to the acquisition of the material or equipment covered thereby. Samples remaining upon completion of the work shall be picked up and disposed of in accordance with manufacturer's Material Safety Data Sheets (MSDS) and in compliance with existing laws and regulations.

3.2 SUBMITTAL REGISTER (ENG FORM 4288-R)

At the end of this section is one set of ENG FORM 4288-R listing items of equipment and materials for which submittals are required by the specifications; this list may not be all inclusive and additional submittals may be required. A copy of ENG FORM 4288-R is also included at the end of this section. The Contractor will also be given the submittal register as a diskette containing the computerized ENG FORM 4288-R and instructions on the use of the diskette. Columns "d" through "q" have been completed by the Government; the Contractor shall complete columns "a" and "r" through "t" and submit the forms (hard copy plus associated electronic file) to the Contracting Officer for approval within 15 calendar days after Notice to Proceed. The Contractor shall keep this diskette up-to-date and shall submit it to the Government together with the monthly payment request. The approved submittal

register will become the scheduling document and will be used to control submittals throughout the life of the contract. The submittal register and the progress schedules shall be coordinated.

3.3 SCHEDULING

Submittals covering component items forming a system or items that are interrelated shall be scheduled to be coordinated and submitted concurrently. Certifications to be submitted with the pertinent drawings shall be so scheduled. Adequate time (a minimum of 30 calendar days exclusive of mailing time) shall be allowed and shown on the register for review and approval. No delay damages or time extensions will be allowed for time lost in late submittals.

3.4 TRANSMITTAL FORM (ENG FORM 4025-R)

The sample transmittal form (ENG FORM 4025-R) attached to this section shall be used for submitting both Government approved and information only submittals in accordance with the instructions on the reverse side of the form. These forms will be furnished to the Contractor. This form shall be properly completed by filling out all the heading blank spaces and identifying each item submitted. Special care shall be exercised to ensure proper listing of the specification paragraph and/or sheet number of the contract drawings pertinent to the data submitted for each item.

3.5 SUBMITTAL PROCEDURE

Submittals shall be made as follows:

3.5.1 Procedures

Submittals shall be prepared as specified with the required number of copies and delivered to:

3.5.2 Deviations

For submittals which include proposed deviations requested by the Contractor, the column "variation" of ENG Form 4025-R shall be checked. The Contractor shall set forth in writing the reason for any deviations and annotate such deviations on the submittal. The Government reserves the right to rescind inadvertent approval of submittals containing unnoted deviations.

3.6 CONTROL OF SUBMITTALS

The Contractor shall carefully control his procurement operations to ensure that each individual submittal is made on or before the Contractor scheduled submittal date shown on the approved "Submittal Register."

3.7 GOVERNMENT APPROVED SUBMITTALS

Upon completion of review of submittals requiring Government approval, the submittals will be identified as having received approval by being so stamped and dated. An original and four (4) copies of the submittal will be retained by the Contracting Officer and two (2) copies of the submittal will be returned to the Contractor.

3.8 INFORMATION ONLY SUBMITTALS

Approval of the Contracting Officer is not required on information only submittals. The Government reserves the right to require the Contractor to resubmit any item found not to comply with the contract. This does not relieve the Contractor from the obligation to furnish material conforming to the plans and specifications; will not prevent the Contracting Officer from requiring removal and replacement of nonconforming material incorporated in the work; and does not relieve the Contractor of the requirement to furnish samples for testing by the Government laboratory or for check testing by the Government in those instances where the technical specifications so prescribe.

3.9 STAMPS

Stamps used by the Contractor on the submittal data to certify that the submittal meets contract requirements shall be similar to the following:

CONTRACTOR (Firm Name)
_____ Approved
_____ Approved with corrections as noted on submittal data and/or attached sheets(s)
SIGNATURE: _____
TITLE: _____
DATE: _____

End of Section

INSTRUCTIONS

1. Section 1 will be initiated by the Contractor in the required number of copies.
2. Each transmittal shall be numbered consecutively in the space provided for "Transmittal No.". This number, in addition to the contract number, will form a serial number for identifying each submittal. For new submittals or resubmits mark the appropriate box; on resubmittals, insert transmittal number of last submission as well as the new submittal number.
3. The "Item No." will be the same "Item No." as indicated on ENG FORM 4288-R for each entry on this form.
4. Submittals requiring expeditious handling will be submitted on a separate form.
5. Separate transmittal form will be used for submittals under separate sections of the specifications.

INSTRUCTIONS

1. Section 1 will be initiated by the Contractor in the required number of copies.
2. Each transmittal shall be numbered consecutively in the space provided for "Transmittal No.". This number, in addition to the contract number, will form a serial number for identifying each submittal. For new submittals or resubmits mark the appropriate box; on resubmittals, insert transmittal number of last submission as well as the new submittal number.
3. The "Item No." will be the same "Item No." as indicated on ENG FORM 4288 for each entry on this form.
4. Submittals requiring expeditious handling will be submitted on a separate form.
5. Separate transmittal form will be used for submittals under separate sections of the specifications.
6. A check shall be placed in the "Variation" column when a submittal is not in accordance with the plans and specifications--also, a written statement to that effect shall be included in the space provided for "Remarks".
7. Form is self-transmittal, letter of transmittal is not required.
8. When a sample of material or Manufacturer's Certificate of Compliance is transmitted, indicate "Sample" or "Certificate" in column c, Section I.
9. U.S. Army Corps of Engineers approving authority will assign action codes as indicated below in space provided in Section I, column i to each item submitted. In addition they will ensure enclosures are indicated and attached to the form prior to return to the Contractor. The Contractor will assign action codes as indicated below in Section I, column g, to each item submitted.

THE FOLLOWING ACTION CODES ARE GIVEN TO ITEMS SUBMITTED

- | | | | | | |
|---|----|---|----|----|---|
| A | -- | Approved as submitted. | E | -- | Disapproved (See attached). |
| B | -- | Approved, except as noted on drawings. | F | -- | Receipt acknowledge. |
| C | -- | Approved, except as noted on drawings.
Refer to attached sheet resubmission required | FX | -- | Receipt acknowledged, does not comply
as noted with contract requirements. |
| D | -- | Will be returned by separate correspondence. | G | -- | Other (<i>Specify</i>) |
10. Approval of items does not relieve the Contractor from complying with all the requirements of the contract plans and specifications.

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

(Proponent CEMP-CE)

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[illegible]

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[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

(Proponent CEMP-CE)

[illegible]

[illegible]

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SUBMITTAL REGISTER (ER 415-1-10)																		CONTRACT NO.							
TITLE AND LOCATION NEW MADRID PUMPING STATION NEW MADRID, MISSOURI										CONTRACTOR								SPECIFICATION SECTION 03301							
ACTIVITY NO.	TRANS-MITTAL NO.	ITEM NO.	SPECIFICATION PARAGRAPH NUMBER	DESCRIPTION OF ITEM SUBMITTED	TYPE OF SUBMITTAL										CLASSIFICATION	REVIEWER	CONTRACTOR SCHEDULE DATES			CONTRACTOR ACTION		GOVERNMENT ACTION		REMARKS	
					DRAWINGS	INSTRUCTIONS	SCHEDULES	STATEMENTS	REPORTS	CERTIFICATIONS	SAMPLES	RECORDS	FORMATION	GOVERNMENT			APPROVAL NEEDED BY	MATERIAL NEEDED BY	DATE	SUBMIT TO GOVERN- MENT	DATE	REMARKS			
a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x	y	z
			1.2	Batch Plant	X										X										
			1.2	Ready Mix Plant	X										X										
			1.2	Concrete Mixers	X										X										
			1.2	Conveying Methods	X										X										
			1.2	Placing Equipment & Methods	X										X										
			1.2	Concrete Mixing						X					X										
			1.4	Concrete Mix	X					X					X										
			2.1.1	Cementitious Materials							X	X			X										
			2.1.2	Aggregates					X					X											
			2.1.3	Chemical Admixtures							X	X			X										
			2.1.4	Curing Materials							X	X			X										
			2.1.6	Non-Shrink Grout							X				X										
			2.1.7	Abrasive Aggregates							X				X										
			2.1.8	Bonding Compounds							X				X										
			2.1.9	Epoxy Resins							X				X										
			2.2	Concrete Mixture Proportioning	X					X					X										
			3.1.2	Batch Plant	X										X										
			3.1.3	Concrete Mixers	X										X										
			3.1.4	Conveying Equipment	X										X										
			3.1.5	Vibrators	X										X										

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SUBMITTAL REGISTER (ER 415-1-10)																	CONTRACT NO.											
TITLE AND LOCATION					NEW MADRID PUMPING STATION NEW MADRID, MISSOURI												CONTRACTOR					SPECIFICATION SECTION 04200						
ACTIVITY NO. a	TRANS-MITTAL NO. b	ITEM NO. c	SPECIFICATION PARAGRAPH NUMBER d	DESCRIPTION OF ITEM SUBMITTED e	TYPE OF SUBMITTAL										CLASSIFICATION		REVIEWER q	CONTRACTOR SCHEDULE DATES			CONTRACTOR ACTION		GOVERNMENT ACTION		REMARKS z			
					DRAWINGS f	INSTALLATIONS g	SCHEDULES h	STATEMENTS i	REPORTS j	CERTIFICATES k	SAMPLES l	RECORDS m	INFORMATION ONLY n	GOVERNMENT REQUIRED o	APPROVAL NEEDED BY r	MATERIAL NEEDED BY t		DATE u	SUBMIT TO GOVERNMENT v	DATE x								
			1.2	Masonry Work		X									X													
			1.2	Cold Weather Installation					X						X													
			1.3.3	Masonry Work		X									X													
			1.5	Masonry Inspection						X					X													
			2.3	Concrete Masonry Units	X						X	X			X													
			2.4	Concrete Masonry Units	X						X	X			X													
			2.4.3	Architectural Masonry Units	X						X	X			X													
			2.5	Masonry Cement							X				X													
			2.5	Mortar Proportioning	X										X													
			2.5.1	Admixtures							X			X														
			2.5.2	Mortar Color	X									X														
			2.6	Grout											X													
			2.7	Ties and Anchors								X			X													
			2.8	Reinforcing		X					X				X													
			2.9	Reinforcing		X					X				X													
			2.10	Expansion Joint Materials							X				X													
			2.11	Insulation	X						X	X			X													
			3.19.1	Mortar Testing						X					X													
			3.19.2	Grout Testing						X					X													
			3.19.3	Efflorescent Test						X					X													
			3.19.4	Prism Test						X					X													

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ENG FORM 4288-R, MAR 95 EDITION OF SEP 93 IS OBSOLETE PAGE 40 OF 64 PAGES (Proponent CEMP-CE)

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SUBMITTAL REGISTER (ER 415-1-10)																	CONTRACT NO.								
TITLE AND LOCATION					NEW MADRID PUMPING STATION NEW MADRID, MISSOURI												CONTRACTOR			SPECIFICATION SECTION 09940					
ACTIVITY NO.	TRANS-MITTAL NO.	ITEM NO.	SPECIFICATION PARAGRAPH NUMBER	DESCRIPTION OF ITEM SUBMITTED	TYPE OF SUBMITTAL										CLASSIFICATION		CONTRACTOR SCHEDULE DATES			CONTRACTOR ACTION		GOVERNMENT ACTION		REMARKS	
					D A T A	D R A W I N G S	I N S T R U C T I O N S	S C H E D U L E S	S T A T E M E N T S	R E P O R T S	C E R T I F I C A T E S	S A M P L E S	R E C O R D S	I N F O R M A T I O N O N L Y	G O V A R E P N R M O V E N E D	R E V I E W E R	SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	C O D E	DATE	SUBMIT TO GOVERN- MENT	C O D E		DATE
a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x	y	z
			1.3	Qualifications and Experience					X						X										
			1.3	Accident Prevention Plan					X						X										
			1.3	Confined Space Procedures					X						X										
			1.3	Respiratory Protection Program					X						X										
			1.3	Airborne Sampling Plan					X						X										
			1.3	Ventilation Assessment					X						X										
			1.3	Medical Surveillance Plan					X						X										
			1.3	Waste Classification, Handling, and Disposal Plan					X						X										
			1.3	Containment Plan					X						X										
			1.3	Ambient Air Monitoring Plan for Particulate Emissions					X						X										
			1.3	Visible Emissions					X						X										
			1.3	Special Paint Formulas					X			X			X										
			1.3	Specification and Proprietary Paints					X			X			X										
			1.3	Thinners					X			X			X										
			1.3	Inspections and Operations									X		X										
			1.4.1	Certified Personnel							X														
			1.4.2	Testing Laboratory							X			X											

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SUBMITTAL REGISTER (ER 415-1-10)																			CONTRACT NO.			
TITLE AND LOCATION NEW MADRID PUMPING STATION NEW MADRID, MISSOURI										CONTRACTOR							SPECIFICATION SECTION 11212					
ACTIVITY NO. a	TRANS-MITTAL NO. b	ITEM NO. c	SPECIFICATION PARAGRAPH NUMBER d	DESCRIPTION OF ITEM SUBMITTED e	TYPE OF SUBMITTAL										CLASSIFICATION		CONTRACTOR SCHEDULE DATES r	CONTRACTOR ACTION		GOVERNMENT ACTION		REMARKS z
					DRAWINGS f	INSTRUMENTS g	SCHEDULES h	STATEMENTS i	REPORTS j	CERTIFICATES k	SAMPLES l	RECORDS m	FORMAT ONLY n	GOVERNMENT REVIEW o	APPROVAL NEEDED BY s	MATERIAL NEEDED BY t		DATE u	SUBMIT TO GOVERN- MENT w	DATE x		
			1.4	System Description	X										X							
			1.4	Bearings	X										X							
			1.4	Gears	X										X							
			1.4	Shafts	X										X							
			1.4	Couplings	X										X							
			1.4	Backstop	X										X							
			1.4	Housing	X										X							
			1.4	Lubrication System	X	X									X							
			1.4	Instrumentation	X	X									X							
			1.4	Speed Reducers and Related Lubri	X										X							
			1.4	Lubricant	X										X							
			1.4	Reducer Drawings		X									X							
			1.4	Shop Testing						X					X							
			1.4	Field Testing						X					X							
			1.4	Operation and Maintenance Manual			X								X							

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TRANSMITTAL OF SHOP DRAWINGS, EQUIPMENT DATA, MATERIAL SAMPLES, OR MANUFACTURER'S CERTIFICATES OF COMPLIANCE <i>(Read instructions on the reverse side prior to initiating this form)</i>	DATE	TRANSMITTAL NO.
---	------	-----------------

SECTION I - REQUEST FOR APPROVAL OF THE FOLLOWING ITEMS *(This section will be initiated by the contractor)*

TO:	FROM:	CONTRACT NO.	CHECK ONE: <input type="checkbox"/> THIS IS A NEW TRANSMITTAL <input type="checkbox"/> THIS IS A RESUBMITTAL OF TRANSMITTAL _____
-----	-------	--------------	--

SPECIFICATION SEC. NO. <i>(Cover only one section with each transmittal)</i>	PROJECT TITLE AND LOCATION	CHECK ONE: THIS TRANSMITTAL IS FOR <input type="checkbox"/> FIO <input type="checkbox"/> GOV'T. APPROVAL
--	----------------------------	---

ITEM NO.	DESCRIPTION OF ITEM SUBMITTED <i>(Type size, model number/etc.)</i>	MFG OR CONTR. CAT., CURVE DRAWING OR BROCHURE NO. <i>(See instruction no. 8)</i>	NO. OF COPIES	CONTRACT REFERENCE DOCUMENT		FOR CONTRACTOR USE CODE	VARIATION <i>(See instruction No. 6)</i>	FOR CE USE CODE
				SPEC. PARA. NO. <i>e.</i>	DRAWING SHEET NO. <i>f.</i>			
<i>a.</i>	<i>b.</i>	<i>c.</i>	<i>d.</i>	<i>e.</i>	<i>f.</i>	<i>g.</i>	<i>h.</i>	<i>i.</i>

REMARKS	I certify that the above submitted items have been reviewed in detail and are correct and in strict conformance with the contract drawings and specifications except as other wise stated. _____ NAME AND SIGNATURE OF CONTRACTOR
---------	---

SECTION II - APPROVAL ACTION

ENCLOSURES RETURNED <i>(List by Item No.)</i>	NAME, TITLE AND SIGNATURE OF APPROVING AUTHORITY	DATE
---	--	------

INSTRUCTIONS

1. Section I will be initiated by the Contractor in the required number of copies.
2. Each transmittal shall be numbered consecutively in the space provided for "Transmittal No.". This number, in addition to the contract number, will form a serial number for identifying each submittal. For new submittals or resubmittals mark the appropriate box; on resubmittals, insert transmittal number of last submission as well as the new submittal number.
3. The "Item No." will be the same "Item No." as indicated on ENG FORM 4288-R for each entry on this form.
4. Submittals requiring expeditious handling will be submitted on a separate form.
5. Separate transmittal form will be used for submittals under separate sections of the specifications.
6. A check shall be placed in the "Variation" column when a submittal is not in accordance with the plans and specifications--also, a written statement to that effect shall be included in the space provided for "Remarks".
7. Form is self-transmittal, letter of transmittal is not required.
8. When a sample of material or Manufacturer's Certificate of Compliance is transmitted, indicate "Sample" or "Certificate" in column c, Section I.
9. U.S. Army Corps of Engineers approving authority will assign action codes as indicated below in space provided in Section I, column i to each item submitted. In addition they will ensure enclosures are indicated and attached to the form prior to return to the contractor. The Contractor will assign action codes as indicated below in Section I, column g, to each item submitted.

THE FOLLOWING ACTION CODES ARE GIVEN TO ITEMS SUBMITTED

A	--	Approved as submitted.	E	--	Disapproved (See attached).
B	--	Approved, except as noted on drawings.	F	--	Receipt acknowledged.
C	--	Approved, except as noted on drawings. Refer to attached sheet resubmission required.	FX	--	Receipt acknowledged, does not comply as noted with contract requirements.
D	--	Will be returned by separate correspondence.	G	--	Other (<i>Specify</i>)

10. Approval of items does not relieve the contractor from complying with all the requirements of the contract plans and specifications.

(Reverse of ENG Form 4025-R)

DIVISION 1 - GENERAL REQUIREMENT

SECTION 01450

PROJECT SIGNS, BARRICADES, AND TRAFFIC CONTROL

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PART 3	EXECUTION (NOT APPLICABLE)	1

End of Section Table of Contents

SECTION 01450

PROJECT SIGNS, BARRICADES, AND TRAFFIC CONTROL

PART 1 GENERAL

1.1 SCOPE

The work covered by this section consists of furnishing, erecting, maintaining, and removing project signs, barricades and traffic control signs.

1.2 PROJECT SIGNS

The Contractor shall furnish, erect, and maintain two double-faced project signs, at the specific locations designated by the Contracting Officer. The signs shall be constructed of 3/4-inch marine grade plywood, 3/4-inch A-C exterior plywood, or 22 gage metal, mounted on a substantial framework of 2-inch material. Size, lettering, color, and paint shall conform to the details shown on the drawing "Temporary Project Sign" included at the end of this section. Upon request, the Government will furnish without cost to the Contractor four decals of the Engineer Castle. The signs shall be erected as soon as practicable, but not later than 15 calendar days after the date established for commencement of work. The signs shall be removed upon completion of all other construction work under the contract and will become the property of the Contractor.

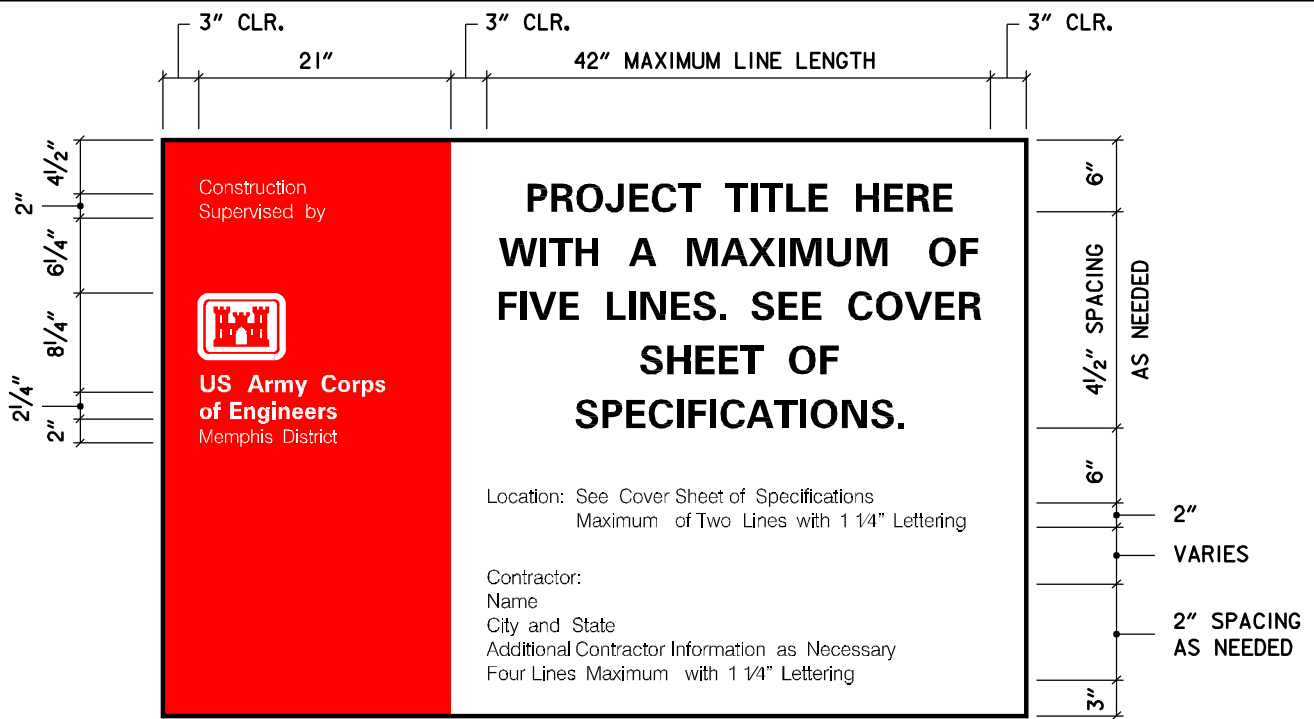
1.3 BARRICADES AND TRAFFIC CONTROL SIGNS

Barricades and traffic control signs shall be those as recommended by the Contracting Officer and conform to the Manual on Uniform Traffic Control Devices for Streets and Highways, Current Edition.

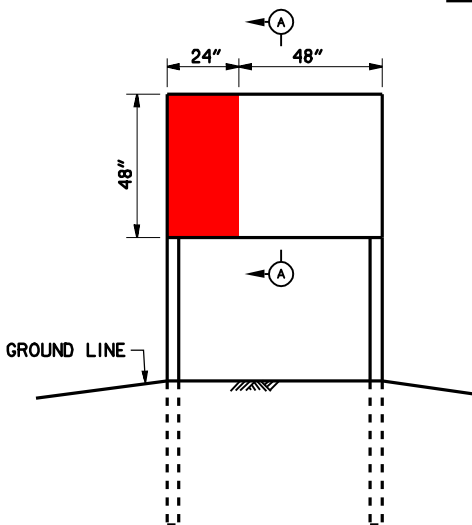
PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION (NOT APPLICABLE)

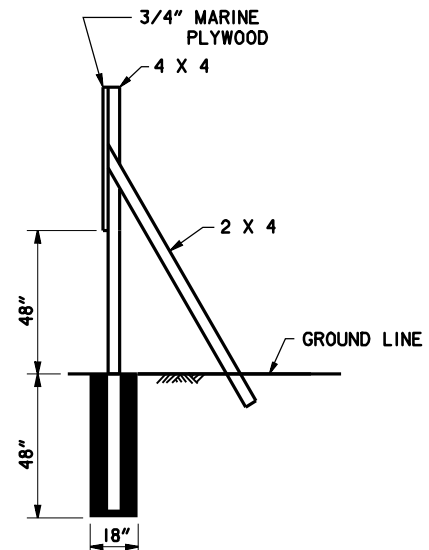
End of Section



ELEVATION



ELEVATION



SECTION A-A

SPECIFICATIONS

- SIGN PANEL SHALL BE 4' x 6' x 3/4" MARINE PLYWOOD OR 22 GAGE SHEET METAL.
- POSTS AND BRACING SHALL BE TREATED, NO.1 GRADE YELLOW PINE.
- ALL EXPOSED SURFACES SHALL BE GIVEN ONE COAT OF LINSEED OIL AND WIPED PRIOR TO PRIMING.
- ALL EXPOSED SURFACES SHALL BE GIVEN ONE COAT OF WHITE AS PRIMER. SECOND COAT SHALL BE COMMUNICATIONS RED ON LEFT AND WHITE ELSEWHERE.
- THE LEFT SECTION SHALL BE RED WITH WHITE LEGEND. THE RIGHT SECTION SHALL BE WHITE WITH BLACK LEGEND.
- PAINT SHALL BE BENJAMIN MOORE NO. 120-60 POLY-SILICONE ENAMEL OR APPROVED
- ALL LETTERING SHALL BE 1/4" EXCEPT FOR THE WORDS "US Army Corps of Engineers" AND THE PROJECT TITLE. THE WORDS "US Army Corps of Engineers" SHALL BE 1/2" TALL. THE PROJECT TITLE LETTERING SHALL BE A MINIMUM OF 1/2" TALL AND A MAXIMUM OF 3/2" TALL. THE LETTERING SIZE SHALL BE CHOSEN SUCH THAT LARGEST POSSIBLE LETTERS ARE USED WITHOUT EXCEEDING A MAXIMUM LINE LENGTH OF 42". THE NUMBER OF LINES IN THE PROJECT TITLE SHALL MATCH THAT SHOWN ON THE COVER SHEET OF THE SPECIFICATIONS.

SCALE: NONE

JUNE 1998

U.S. ARMY ENGINEER DISTRICT, MEMPHIS
CORPS OF ENGINEERS
MEMPHIS, TENNESSEE

**TEMPORARY
PROJECT SIGN**

DIVISION 1 - GENERAL REQUIREMENTS

SECTION 01451

CONTRACTOR QUALITY CONTROL

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SECTION 01451

CONTRACTOR QUALITY CONTROL

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 3740	(1996) Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
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ASTM E 329	(1998) Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction
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1.2 PAYMENT

Separate payment will not be made for providing and maintaining an effective Quality Control program, and all costs associated therewith shall be included in the applicable unit prices or lump-sum prices contained in the Bidding Schedule.

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION

3.1 GENERAL

The Contractor is responsible for quality control and shall establish and maintain an effective quality control system in compliance with the Contract Clause entitled "Inspection of Construction." The quality control system shall consist of plans, procedures, and organization necessary to produce an end product which complies with the contract requirements. The system shall cover all construction operations, both on-site and off-site, and shall be keyed to the proposed construction sequence.

3.2 QUALITY CONTROL PLAN

3.2.1 General

The Contractor shall furnish for review by the Government, not later than 21 calendar days after receipt of Notice of Award of the contract, the Contractor Quality Control (CQC) Plan proposed to implement the requirements of the Contract Clause entitled "Inspection of Construction." The plan shall identify personnel, procedures, control, instructions, test, records, and forms to be used. The Government will consider an interim plan for the first 15 days of operation. Construction will be permitted to begin only after acceptance of the CQC Plan or acceptance of an interim plan applicable to the particular feature of

work to be started. Work outside of the features of work included in an accepted interim plan will not be permitted to begin until acceptance of a CQC Plan or another interim plan containing the additional features of work to be started.

3.2.2 Content of the CQC Plan

The CQC plan shall include, as a minimum, the following to cover all construction operations, both on-site and off-site, including work by subcontractors, fabricators, suppliers, and purchasing agents:

- a. A description of the quality control organization, including a chart showing lines of authority and acknowledgment that the CQC staff shall implement the three phase control system for all aspects of the work specified. The staff shall include a CQC system manager who shall report to the project manager or someone higher in the Contractor's organization. Project manager in this context shall mean the individual with responsibility for the overall management of the project including quality and production.
- b. The name, qualifications (in resume format), duties, responsibilities, and authorities of each person assigned a CQC function.
- c. A copy of the letter to the CQC System Manager signed by an authorized official of the firm which describes the responsibilities and delegates sufficient authorities to adequately perform the functions of the CQC System Manager, including authority to stop work which is not in compliance with the contract. The CQC System Manager shall issue letters of direction to all other various quality control representatives outlining duties, authorities, and responsibilities. Copies of these letters will also be furnished to the Government.
- d. Procedures for scheduling, reviewing, certifying, and managing submittals, including those of subcontractors, off-site fabricators, suppliers, and purchasing agents. These procedures shall be in accordance with Section 00800 SPECIAL CONTRACT REQUIREMENT entitled "Submittals".
- e. Control, verification, and acceptance testing procedures for each specific test to include the test name, specification paragraph requiring test, feature of work to be tested, test frequency, and person responsible for each test. (Laboratory facilities will be approved by the Contracting Officer.)
- f. Procedures for tracking preparatory, initial, and follow-up control phases and control, verification, and acceptance tests including documentation.
- g. Procedures for tracking construction deficiencies from identification through acceptable corrective action. These procedures will establish verification that identified deficiencies have been corrected.
- h. Reporting procedures, including proposed reporting formats.
- i. A list of the definable features of work. A definable feature of work is a task which is separate and distinct from other tasks and has separate control requirements. It could be identified by different trades or disciplines, or it could be work by the same trade in a different environment. Although each section of the specifications may generally be considered as a definable feature

of work, there are frequently more than one definable feature under a particular section. This list will be agreed upon during the coordination meeting.

3.2.3 Acceptance of Plan

Acceptance of the Contractor's plan is required prior to the start of construction. Acceptance is conditional and will be predicated on satisfactory performance during the construction. The Government reserves the right to require the Contractor to make changes in his CQC plan and operations including removal of personnel, as necessary, to obtain the quality specified.

3.2.4 Notification of Changes

After acceptance of the QC plan, the Contractor shall notify the Contracting Officer in writing a minimum of seven calendar days prior to any proposed change. Proposed changes are subject to acceptance by the Contracting Officer.

3.3 COORDINATION MEETING

After the Preconstruction Conference, before start of construction, and prior to acceptance by the Government of the Quality Control Plan, the Contractor shall meet with the Contracting Officer or Authorized Representative and discuss the Contractor's quality control system. During the meeting, a mutual understanding of the system details shall be developed, including the forms for recording the CQC operations, control activities, testing, administration of the system for both on-site and off-site work, and the interrelationship of Contractor's Management and control with the Government's Quality Assurance. Minutes of the meeting shall be prepared by the Government and signed by both the Contractor and the Contracting Officer. The minutes shall become a part of the contract file. There may be occasions when subsequent conferences will be called by either party to reconfirm mutual understandings and/or address deficiencies in the CQC system or procedures which may require corrective action by the Contractor.

3.4 QUALITY CONTROL ORGANIZATION

3.4.1 CQC System Manager

The Contractor shall identify an individual within his organization at the worksite who shall be responsible for overall management of CQC and have the authority to act in all CQC matters for the Contractor. This CQC System Manager shall be subject to acceptance by the Contracting Officer. The CQC System Manager shall be assigned as System Manager but may not have other duties in addition to quality control.

3.4.2 CQC Staff

A staff shall be maintained under the direction of the CQC System Manager to perform all CQC activities. An alternate will be identified to serve in the absence of the CQC System Manager. The staff must be of sufficient size to ensure adequate CQC coverage of all work phases, work shifts, and work crews involved in the construction. These personnel may perform other duties, but must be fully qualified by experience and technical training to perform their assigned CQC responsibilities and must be allowed sufficient time to carry out these responsibilities. The CQC plan will clearly state the duties and responsibilities of each staff member. All CQC Staff members or replacements shall be subject to acceptance by the Contracting Officer.

3.4.3 Additional Requirement

In addition to the above requirements, the CQC System Manager and all personnel designated as alternates shall complete the course entitled "Construction Quality Management for Contractors". This course is periodically offered by the Memphis District as well as other Corps Districts.

3.5 SUBMITTALS

Submittals shall be in accordance with Section 00800 SPECIAL CONTRACT REQUIREMENT entitled "Submittals". The CQC organization shall be responsible for certifying that all submittals are in compliance with the contract requirements.

3.6 CONTROL

The controls shall include at least three phases of control to be conducted by the CQC System Manager for all definable features of work, as follows:

3.6.1 Preparatory Phase

This phase shall be performed prior to beginning work on each definable feature of work and shall include:

- a. A review of each paragraph of applicable specifications.
- b. A review of the contract drawings.
- c. A check to assure that all materials and/or equipment have been tested, submitted, and approved.
- d. A check to assure that provisions have been made to provide required control inspection and testing.
- e. Examination of the work area to assure that all required preliminary work has been completed and is in compliance with the contract.
- f. A physical examination of required materials, equipment, and sample work to assure that they are on hand, conform to approved shop drawings or submitted data, and are properly stored.
- g. A review of the appropriate activity hazard analysis to assure safety requirements are met.
- h. Discussion of procedures for constructing the work including repetitive deficiencies. Document construction tolerances and workmanship standards for that phase of work.
- i. A check to ensure that the portion of the plan for the work to be performed has been accepted by the Contracting Officer.
- j. The Government shall be notified at least 24 hours in advance of beginning any of the required action of the preparatory phase. This phase shall include a meeting conducted by the CQC System Manager and attended by the superintendent, other CQC personnel (as applicable), and the foreman responsible for the definable feature. The results of the preparatory phase actions shall be documented by separate minutes prepared by the CQC System Manager and attached

to the daily CQC report. The Contractor shall instruct applicable workers as to the acceptable level of workmanship required in order to meet contract specifications.

3.6.2 Initial Phase

This phase shall be accomplished at the beginning of a definable feature of work. The following shall be accomplished:

- a. A check of preliminary work to ensure that it is in compliance with contract requirements. Review minutes of the preparatory meeting.
- b. Verification of full contract compliance. Verify required control inspection and testing.
- c. Establish level of workmanship and verify that it meets minimum acceptable workmanship standards. Compare with sample panels as appropriate.
- d. Resolve all differences.
- e. Check safety to include compliance with and upgrading of the safety plan and activity hazard analysis. Review the activity analysis with each worker.
- f. The Government shall be notified at least 24 hours in advance of beginning the initial phase. Separate minutes of this phase shall be prepared by the CQC System Manager and attached to the daily CQC report. Exact location of initial phase shall be indicated for future reference and comparison with follow-up phases.
- g. The initial phase should be repeated for each new crew to work on-site, or any time acceptable quality standards are not being met.

3.6.3 Follow-up Phase

Daily checks shall be performed to assure continuing compliance with contract requirements, including control testing, until completion of the particular feature of work. The checks shall be made a matter of record in the CQC documentation. Final follow-up checks shall be conducted and all deficiencies corrected prior to the start of additional features of work which may be affected by the deficient work. The Contractor shall not build upon or conceal non-conforming work.

3.6.4 Additional Preparatory and Initial Phases

As determined by the Government, additional preparatory and initial phases may be conducted on the same definable features of work if the quality of on-going work is unacceptable, if there are changes in the applicable CQC staff, on-site production supervision or work crew, if work on a definable feature is resumed after a substantial period of inactivity, or if other problems develop.

3.7 TESTS

3.7.1 Testing Procedure

The Contractor shall perform specified or required tests to verify that control measures are adequate to provide a product which conforms to contract requirements. Testing includes operation and/or acceptance

tests when specified. The Contractor shall procure the services of a Corps of Engineers approved testing laboratory or establish an approved testing laboratory at the project site. The Contractor shall perform the following activities and record and provide the following data:

- a. Verify that testing procedures comply with contract requirements.
- b. Verify that facilities and testing equipment are available and comply with testing standards.
- c. Check test instrument calibration data against certified standards.
- d. Verify that recording forms and test identification control number system, including all of the test documentation requirements, have been prepared.

e. Results of all tests taken, both passing and failing tests, will be recorded on the CQC report for the date taken. Specification paragraph reference, location where tests were taken, and the sequential control number identifying the test will be given. If approved by the Contracting Officer, actual test reports may be submitted later with a reference to the test number and date taken. An information copy of tests performed by an off-site or commercial test facility will be provided directly to the Contracting Officer. Failure to submit timely test reports as stated may result in nonpayment for related work performed and disapproval of the test facility for this contract.

3.7.2 Testing Laboratories

3.7.2.1 Capability Check

The Contracting Officer reserves the right to check laboratory equipment in the proposed laboratory for compliance with the standards set forth in the contract specifications and to check the laboratory technician's testing procedures and techniques. Laboratories utilized for testing soils, concrete, asphalt, and steel shall meet criteria detailed in ASTM D 3740 and ASTM E 329.

3.7.2.2 Capability Recheck

If the selected laboratory fails the capability check, the Contractor will be assessed a charge to reimburse the Government for each succeeding recheck of the laboratory or the checking of a subsequently selected laboratory. Such costs will be deducted from the contract amount due the Contractor. There will be no extension of time allowed due to necessity to perform capability rechecks.

3.7.3 On-Site Laboratory

The Contracting Officer reserves the right to utilize the Contractor's control testing laboratory and equipment to make assurance tests and to check the Contractor's testing procedures, techniques, and test results at no additional cost to the Government.

3.7.4 Furnishing or Transportation of Samples for Testing

Costs incidental to the transportation of samples or materials will be borne by the Contractor. Samples of materials for test verification and acceptance testing by the Government shall be delivered by the Contractor to a location specified by the Contracting Officer.

3.8 COMPLETION INSPECTION

At the completion of all work or any increment thereof established by a completion time stated in the Section 00800 SPECIAL CONTRACT REQUIREMENTS entitled "Commencement, Prosecution, and Completion of Work," or stated elsewhere in the specifications, the CQC System Manager shall conduct an inspection of the work and develop a "punch list" of items which do not conform to the approved drawings and specifications. Such a list of deficiencies shall be included in the CQC documentation, as required by paragraph DOCUMENTATION below, and shall include the estimated date by which the deficiencies will be corrected. The CQC System Manager or staff shall make a second inspection to ascertain that all deficiencies have been corrected and so notify the Government. These inspections and any deficiency corrections required by this paragraph will be accomplished within the time stated for completion of the entire work or any particular increment thereof if the project is divided into increments by separate completion dates.

3.9 DOCUMENTATION

The Contractor shall maintain current records providing factual evidence that required quality control activities and/or tests have been performed. These records shall include the work of subcontractors and suppliers and shall be on an acceptable form that includes, as a minimum, the following information:

- a. Contractor/subcontractor and their area of responsibility.
- b. Operating plant/equipment with hours worked, idle, or down for repair.
- c. Work performed each day, giving location, description, and by whom. When Network Analysis (NAS) is used, identify each phase of work performed each day by NAS activity number.
- d. Test and/or control activities performed with results and references to specifications/drawings requirements. The control phase should be identified (Preparatory, Initial, Follow-up). List deficiencies noted along with corrective action.
- e. Quantity of materials received at the site with statement as to acceptability, storage, and reference to specifications/drawings requirements.
- f. Submittals reviewed, with contract reference, by whom, and action taken.
- g. Off-site surveillance activities, including actions taken.
- h. Job safety evaluations stating what was checked, results, and instructions or corrective actions.
- i. Instructions given/received and conflicts in plans and/or specifications.
- j. Contractor's verification statement.

These records shall indicate a description of trades working on the project; the number of personnel working; weather conditions encountered; and any delays encountered. These records shall cover both conforming and deficient features and shall include a statement that equipment and materials incorporated in the work and workmanship comply with the contract. The original and one copy of these records in report form shall be furnished to the Government daily within 24 hours after the date(s) covered by the

report, except that reports need not be submitted for days on which no work is performed. As a minimum, one report shall be prepared and submitted for every seven days of no work and on the last day of a no work period. All calendar days shall be accounted for throughout the life of the contract. The first report following a day of no work shall be for that day only. Reports shall be signed and dated by the CQC System Manager. The report from the CQC System Manager shall include copies of test reports and copies of reports prepared by all subordinate quality control personnel.

3.10 NOTIFICATION OF NONCOMPLIANCE

The Contracting Officer will notify the Contractor of any detected noncompliance with the foregoing requirements. The Contractor shall take immediate corrective action after receipt of such notice. Such notice, when delivered to the Contractor at the worksite, shall be deemed sufficient for the purpose of notification. If the Contractor fails or refuses to comply promptly, the Contracting Officer may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No part of the time lost due to such stop orders shall be made the subject of claim for extension of time or for excess costs or damages by the Contractor.

End of Section

DIVISION 2 - SITE WORK

SECTION 02111

CLEARING AND GRUBBING

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SECTION 02111

CLEARING AND GRUBBING

PART 1 GENERAL (Not Applicable)

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

All clearing and grubbing work for levee embankments and berm shall be completed at least 500 feet in advance of levee embankment or berm construction. In locations where work on drainage structures is performed prior to embankment construction, all clearing and grubbing shall be completed in advance of the structure and for at least 100 feet on each side of the structure, measured along the levee centerline. If regrowth of vegetation or trees occurs after clearing and grubbing and before placement of fill, the Contractor will be required to clear and grub the area again prior to levee embankment and berm construction, and no payment will be made for this additional clearing and grubbing.

3.2 CLEARING

3.2.1 General

Clearing, unless otherwise specified, shall consist of the complete removal above the ground surface, except as indicated below, of all trees, stumps, down timber, snags, brush, vegetation, old piling, loose stone, abandoned structures, abandoned fencing, fencing, drift, and similar debris.

3.2.2 Merchantable Timber

Merchantable timber remaining within the areas to be cleared on or after the date of award of this contract may be disposed of as the Contractor sees fit, as long as such merchantable timber is either removed from the rights-of-way indicated on the drawings or is satisfactorily disposed of in accordance with paragraph DISPOSAL OF DEBRIS. Contractor is precluded from making any claim for time extensions, costs, or damage to his operations by reason of the existence or nonexistence of merchantable timber, crops, debris, or stumps within the areas to be cleared.

3.2.3 Trees

Trees shall be felled in such a manner so as to avoid damage to trees to be left standing, to existing structures and installations, and to those under construction, and with due regard for the safety of employees and others.

3.2.4 Vegetation

Vegetation to be removed shall consist of crops, grass, bushes and weeds. Close-growing grass and other vegetation shall be removed from areas to receive semicompacted or compacted fill to provide a

completely bare earth surface immediately prior to foundation preparation. Acceptance of the vegetation removal operation shall precede the initiation of foundation preparation in the area from which vegetation has been removed.

3.2.5 Areas to be Cleared

3.2.5.1 General

The entire area to be occupied by the levee embankment and berm, together with strips 5 feet wide contiguous thereto, road ramps, above ground structures, riprap, channels, and drainage ditches shall be cleared.

3.2.5.2 Borrow Areas

Only those portions of borrow areas from which borrow materials will actually be obtained under this contract shall be cleared to the extent necessary to provide materials free from unsuitable matter as described in Section 02330 EMBANKMENT FOR LEVEES, paragraph UNSUITABLE MATERIALS.

3.3 GRUBBING

3.3.1 General

Grubbing shall consist of the removal of all stumps, roots, buried logs, old piling, old paving, old foundations, pipes, drains, and other unsuitable matter as described in Section 02330 EMBANKMENT FOR LEVEES paragraph UNSUITABLE MATERIALS.

3.3.2 Areas to be Grubbed

3.3.2.1 Levee Embankment and Structures

Grubbing shall be performed within the limits of the levee embankment and all structures together with the 5-foot strips contiguous thereto. All roots and other projections over 1-1/2 inches in diameter shall be removed to a depth of 3 feet below the natural surface of the ground or surface of existing embankments and to a depth of 3 feet below the subgrade for the foundation of structures. The areas to be grubbed are those specific areas, within the limits specified herein, from which trees, stumps, down timber, snags, old piling, abandoned structures, and other projections have been removed.

3.3.2.2 Channels and Ditches

All stumps and exposed roots and other obstructions shall be removed from within the limits of all channels and ditches to be constructed.

3.3.2.3 Berms and Channel Fill

Grubbing of areas which are to be occupied by either berms and channel fill shall comply with the provisions of paragraph LEVEE EMBANKMENT AND STRUCTURES.

3.3.3 Borrow Areas

Borrow for this project will be provided by the government. Only those portions of borrow areas from which borrow material will actually be obtained under this contract shall be grubbed to the extent necessary to provide materials free from unsuitable matter as described in Section 02330 EMBANKMENT FOR LEVEES, paragraph UNSUITABLE MATERIALS.

3.3.4 Pipes and Drains

The Contractor shall inform the Contracting Officer of all pipes and drains not shown on the drawings which are encountered during grubbing. Such pipe and drains shall not be removed or disturbed until so directed by the Contracting Officer. Material excavated in the process of removing pipes and drains shall be disposed of as specified in Section 02222 EXCAVATION FOR LEVEES, paragraph DISPOSAL OF MATERIALS.

3.3.5 Filling of Holes

All holes caused by grubbing operations excluding holes in borrow areas, channels and ditches, shall be backfilled with suitable material in 12 inch layers to the elevation of the adjacent ground surface, and each layer compacted to a density at least equal to that of the adjoining undisturbed material.

3.4 DISPOSAL OF DEBRIS

3.4.1 General

The primary method of disposing of all debris resulting from clearing and grubbing operations shall be burning as specified in paragraph BURNING. The following additional methods will also be permitted: burying in the borrow area, as limited by paragraph BURYING, or removal from the site in accordance with paragraph REMOVAL FROM SITE OF WORK. The Contractor shall make a reasonable effort to channel merchantable material into the commercial market to make beneficial use of materials resulting from clearing and grubbing operations.

3.4.2 Burning

The Contractor shall comply with the applicable pollution restrictions of the State and Title 40, Code of Federal Regulations, Part 76. Subject to such restrictions and obtaining any permit which may be required by said State or Federal agency, the Contractor may burn material within the contract area at any time within the contract period. Burning operations shall be conducted so as to prevent damage to standing timber or other flammable growth. The Contractor shall be responsible for any damage to life and/or property resulting from fires that are started by his employees or as a result of his operations. The Contractor shall furnish, at the site of burning operations, adequate fire fighting equipment to properly equip his personnel for fighting fires. Fires shall be guarded at all times and shall be under constant surveillance until they have been extinguished.

3.4.3 Burying

The Contractor will be allowed to bury unburned debris. All inorganic materials not burnable, such as appliances, are to be removed from the site for disposal at suitable facilities. The area available for burial will be coordinated with the Contracting Officer. All material disposed of by burying shall be covered with a minimum of 24 inches of earth.

3.4.4 Removal from Site of Work

The Contractor may elect to remove all or part of the debris from the site of the work. Such disposal shall comply with all applicable Federal, State, and local laws. The Contractor shall, at his option, either retain for his own use or dispose of by sale or otherwise, any such materials of value. The Government is not responsible for the protection and safekeeping of any materials retained by the Contractor. Such materials shall be removed from the site of the work before the date of completion of the work. If debris from clearing operations is placed on adjacent property, the Contractor shall obtain, without cost to the Government, additional right-of-way for such purposes in accordance with Special Contract Requirements "RIGHTS-OF-WAY." Such material shall be so placed as not to interfere with roads, drainage or other improvements and in such a manner as to eliminate the possibility of its entering into channels, ditches, or streams. The Contracting Officer reserves the right to approve or disapprove the use of Contractor-furnished disposal areas based on the location of the areas and a determination of the overall impact the proposed disposal will have on the environment or the integrity of the levee. Contractor-furnished disposal areas shall not be located in woodlands or wetlands.

End of Section

DIVISION 2 - SITE WORK

SECTION 02215

GEOTEXTILES USED AS FILTERS

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SECTION 02215

GEOTEXTILES USED AS FILTERS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 123	(1996a) Standard Terminology Relating to Textiles
ASTM D 1683	(1990a) Failure in Sewn Seams of Woven Fabrics
ASTM D 3884	(1992) Abrasion Resistance of Textile Fabrics (Rotary Platform, Double-Head Method)
ASTM D 4354	(1996) Sampling of Geosynthetics for Testing
ASTM D 4355	(1992) Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water (Xenon-Arc Type Apparatus)
ASTM D 4491	(1996) Water Permeability of Geotextiles by Permittivity
ASTM D 4533	(1991) Trapezoid Tearing Strength of Geotextiles
ASTM D 4632	(1991) Grab Breaking Load and Elongation of Geotextiles
ASTM D 4751	(1995) Determining Apparent Opening Size of a Geotextile
ASTM D 4833	88 (1996)e1 Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
ASTM D 4873	(1995) Guide for Identification, Storage, and Handling of Geosynthetic Rolls
ASTM D 4884	(1996) Strength of Sewn or Thermally Bonded Seams of Geotextiles

1.2 SUBMITTALS

Government approval is required for all submittals with a “GA” designation; submittals having an “FIO” designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-13 Certificates

Geotextile; FIO.

The Contractor shall submit a certification of the geotextile material from the manufacturer. All brands of geotextile and all seams to be used shall be accepted on the basis of mill certificates or affidavits. The Contractor shall furnish the Contracting Officer, in duplicate, a mill certificate or affidavit signed by a legally authorized official from the company manufacturing the geotextile. The mill certificate or affidavit shall attest that the geotextile meets the chemical, physical and manufacturing requirements stated in this specification.

SD-14 Samples

Geotextile; FIO.

If requested by the Contracting Officer, the Contractor shall provide to the Government geotextile samples for testing to determine compliance with any or all of the requirements in this specification. When samples are to be provided, they shall be submitted a minimum of 60 days prior to the beginning of installation of the same textile. A written certificate of compliance signed by a legally authorized official from the company shall be submitted, in duplicate, upon delivery of the geotextile. The certificate shall state that the geotextile shipped to the site meets the chemical requirements and exceeds the minimum average roll value listed in TABLE 1, MINIMUM PHYSICAL REQUIREMENTS FOR DRAINAGE GEOTEXTILE. Upon request, the Contractor shall supply quality control and quality assurance tests for the geotextile. All samples provided shall be from the same production lot as will be supplied for the contract, and shall be the full manufactured width of the geotextile by at least 10 feet long, except that samples for seam strength may be a full width sample folded over and the edges stitched for a length of at least 5 feet. Samples submitted for testing shall be identified by manufacturer’s lot designation. For needle punched geotextile, the manufacturer shall certify that the geotextile has been inspected using permanent on-line metal detectors and does not contain any needles.

1.3 SHIPMENT, HANDLING, STORAGE

1.3.1 Shipment and Storage

Only approved geotextile rolls shall be delivered to the project site. All geotextile shall be labeled, shipped, stored, and handled in accordance with ASTM D 4873. No hooks, tongs, or other sharp instruments shall be used for handling geotextile.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Geotextile

2.1.1.1 General

The geotextile shall be non-woven or woven pervious sheet of plastic yarn as defined by ASTM D 123. The geotextile shall equal or exceed the minimum average roll values listed in TABLE 1, MINIMUM PHYSICAL REQUIREMENTS FOR DRAINAGE GEOTEXTILE. Strength values indicated in the table are for the weaker principal direction.

TABLE 1
MINIMUM PHYSICAL REQUIREMENTS FOR DRAINAGE GEOTEXTILE

Property	Units	Acceptable Values	Test Method
Grab Strength	lb	240 MIN	ASTM D 4632
Abrasion	lb	55 MIN	ASTM D 3884
Seam Strength	lb	215 MIN	ASTM D 4632
Puncture	lb	115 MIN	ASTM D 4833
Burst Strength	psi	450 MIN	ASTM D 3786
Trapezoid Tear	lb	90 MIN	ASTM D 4533
Permeability	cm/sec	5 Ks	ASTM D 4491
Apparent Opening Size	U.S. SIEVE	70-100	ASTM D 4751
Permittivity	sec-l	7 MIN	ASTM D 4491
Ultraviolet Degradation	Percent	7 AT 500 Hrs	ASTM D 4355

2.1.1.2 Geotextile Fiber

Fibers used in the manufacturing of the geotextile shall consist of a long-chain synthetic polymer composed of at least 85 percent by weight of polyolefins, polyesters, or polyamides. Stabilizers and/or inhibitors shall be added to the base polymer if necessary to make the filaments resistant to deterioration caused by ultraviolet light and heat exposure. Reclaimed or recycled fibers or polymer shall not be added to the formulation. Geotextile shall be formed into a network such that the filaments or yarns retain dimensional stability relative to each other, including the edges. The edges of the geotextile shall be finished to prevent the outer fiber from pulling away from the geotextile.

2.1.2 Seams

The seams of the geotextile shall be sewn with thread of a material meeting the chemical requirements given above for geotextile yarn or shall be bonded by cementing or by heat. The sheets of geotextile shall be attached at the factory or another approved location, if necessary, to form sections not less than 1.5 feet wide. Seams shall be tested in accordance with method ASTM D 1683. The strength of the seam shall be not less than 90 percent of the required grab tensile strength of the unaged geotextile in any principal direction.

2.1.3 Securing

The geotextile shall be secured to the embankment or foundation soil by pins to prevent movement prior to placement of revetment materials. Other appropriate means to prevent movement such as staples, sand bags, and stone could also be used. Securing pins shall be inserted through both strips of overlapped geotextile along the line passing through midpoints of the overlap. Securing pins shall be removed as placement of revetment materials are placed to prevent tearing of geotextile or enlarging holes. Maximum spacing between securing pins depends on the steepness of the embankment slope. The maximum pins spacing shall be equal to or less than the values listed in TABLE 2, MAXIMUM SPACING FOR SECURING PINS. When windy conditions prevail at the construction site, the number of pins should be increased upon the demand of the Contracting Officer. Terminal ends of the geotextile shall be anchored with key trench or apron at crest, toe of the slope and upstream and downstream limits of installation.

TABLE 2
MAXIMUM SPACING FOR SECURING PINS

Embankment	Spacing, Feet
Steeper Than 1V On 3H	2
1V On 3H To 1V On 4H	3
Flatter Than 1V On 4H	5

2.2 INSPECTIONS, VERIFICATIONS, AND TESTING

2.2.1 Manufacturing and Sampling

Geotextiles and factory seams shall meet the requirements specified in TABLE 1, MINIMUM PHYSICAL REQUIREMENTS FOR DRAINAGE GEOTEXTILE. Conformance testing shall be performed in accordance with the manufacturer's approved quality control manual. Factory seams shall be sampled at the frequency specified in ASTM D 4884.

2.2.2 Site Verification and Testing

Samples shall be collected at approved locations upon delivery to the site at the request of the Contracting Officer. Samples shall be tested to verify that the geotextile meets the requirements specified in TABLE 1, MINIMUM PHYSICAL REQUIREMENTS FOR DRAINAGE GEOTEXTILE. Samples shall be identified by manufacturer's name, type of geotextile, lot number, roll number, and machine direction. Testing shall be performed at an approved laboratory. Test results from the lot under review shall be submitted and approved prior to deployment of that lot of geotextile. Rolls which are sampled shall be immediately rewrapped in their protective covering.

The Government may take samples for its own quality assurance testing. The Contractor remains responsible for all other QC tests and certifications whether performed by the Contractor or manufacturer/testing laboratory.

PART 3 EXECUTION

3.1 SURFACE PREPARATION

Surface on which the geotextile will be placed shall be prepared, to a relatively smooth surface condition, in accordance with the applicable portion of this specification and shall be free from obstruction, debris, depressions, erosion feature, or vegetation. Any irregularities will be removed so as to insure continuous, intimate contact of the geotextile with all the surface. Any loose material, soft or low density pockets of material, will be removed; erosion features such as rills, gullies etc. must be graded out of the surface before geotextile placement.

3.2 INSTALLATION OF THE GEOTEXTILE

3.2.1 General

The geotextile shall be placed in the manner and at the locations shown. At the time of installation, the geotextile shall be rejected if it has defects, rips, holes, flaws, deterioration or damage incurred during manufacture, transportation or storage.

3.2.2 Placement

The geotextile shall be placed with the long dimension perpendicular to the centerline of the channel and laid smooth and free of tension, stress, folds, wrinkles, or creases. The strips shall be placed to provide a minimum width of 18 inches of overlap for each joint. Temporary pinning of the geotextile to help hold it in place until the granular material or riprap is placed shall be allowed. The temporary pins shall be removed as the granular material, riprap is placed to relieve high tensile stress which may occur during placement of material on the geotextile. Design protection of riprap should be in compliance with EM 1110-2-160. Riprap shall be placed according to Section 02542 STONE PROTECTION. Trimming shall be performed in such a manner that the geotextile shall not be damaged in any way.

3.3 PROTECTION

The geotextile shall be protected at all times during construction from contamination by surface runoff and any geotextile so contaminated shall be removed and replaced with uncontaminated geotextile. Any damage to the geotextile during its installation or during placement of granular filter materials and riprap shall be replaced by the Contractor at no cost to the Government. The work shall be scheduled so that the covering of the geotextile with a layer of the specified material is accomplished within 10 calendar days after placement of the geotextile. Failure to comply shall require replacement of geotextile. The geotextile shall be protected from damage prior to and during the placement of riprap or other materials. Before placement of riprap or other materials, the Contractor shall demonstrate that the placement technique will not cause damage to the geotextile. In no case shall any type of equipment be allowed on the unprotected geotextile.

3.4 OVERLAPPING AND SEAMING

3.4.1 Overlapping

The overlap of geotextile rolls shall be 18 inches. Appropriate measures shall be taken to insure required overlap exists after cushion placement.

3.4.2 Sewn Seams

High strength thread should be used such that seam test should conform to ASTM D 1683. The thread shall meet the chemical, ultraviolet, and physical requirements of the geotextile, and the color shall be different from that of the geotextile. The seam strength shall be equal to the strength required for the fabric in the direction across the seam. Overlapping J-type seams are preferable over prayer-type seams as the overlapping fabric reduces the chance of openings to occur at the seam. Double sewing shall be used specially for field seams to provide a safety factor against undetected missed stitches.

End of Section

DIVISION 2 - SITE WORK

SECTION 02221

EXCAVATION, FILL, BACKFILL AND EMBANKMENT FOR STRUCTURES

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SECTION 02221

EXCAVATION, FILL, BACKFILL AND EMBANKMENT FOR STRUCTURES

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 698	91(1998) Laboratory Compaction Characteristics of Soil Using Standard Effort [12,400 ft-lbf/cu.ft. (600kN-m/cu.m.)]
ASTM D 1556	90(1996)e1 Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 2167	(1994) Density and Unit Weight of Soil in Place by the Rubber Balloon Method
ASTM D 2216	(1998) Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D 2487	(1998) Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D 2922	(1996)e1 Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 General

All materials for backfill and fill shall be free of roots, trash and other objectionable matter and shall be obtained from the required excavations, or from the designated borrow area. No frozen material shall be placed and material shall not be placed against frozen surfaces.

2.1.2 Pervious Backfill

Pervious backfill shall be sand composed of tough, durable particles and shall contain no organic matter nor soft, friable particles. The pervious backfill material shall be clean, free draining sand (SP and SW) classified in accordance with ASTM D 2487 except that no more than 5 percent by weight shall pass a No. 200 sieve.

2.1.3 Random Backfill and Semicompacted Fill

Except as specified below, random backfill and semicompacted fill material shall consist of any or all types of materials (except organic materials) from required excavation or from borrow. Material classified in accordance with ASTM D 2487 (as shown on the Soil Boring Legend) as gravels (GW, GP, GM) and sands (SW, SP, SM) shall not be used as materials unless suitably blended with less pervious material. The addition of less pervious material and the blending shall be accomplished to such a degree that the material is changed to a classification other than gravels (GW, GP, GM) and sands (SW, SP, SM) such as clayey gravel (GC) or clayey sand (SC).

2.1.4 Clay Blanket

Clay blanket material shall be classified as clay (CL) or (CH) by the Unified Soil Classification System.

2.1.5 Frozen Materials

Under no circumstances shall frozen earth, snow, or ice be placed in fill or backfill. The Contracting Officer may require the wasting of frozen material in order that construction may proceed and such material wasted by written order of the Contracting Officer will be paid for in accordance with the Contract Clause "CHANGES". The Contractor may waste frozen material, at his own expense, in order to proceed with the work even when the Contracting Officer has not issued a written order.

2.1.6 Unsuitable Materials

Materials which are classified as unsuitable for fill or backfill material are defined as masses of organic matter, sticks, branches, roots and other debris. As earth may contain excessive amounts of wood, isolated pieces of wood will not be considered objectionable in the embankment provided their length does not exceed 12 inches, their cross-sectional area is less than 4 square inches, and they are distributed throughout the fill. Not more than one percent (by volume) of objectionable material shall be contained in the earth material placed in each cubic yard of the levee or berm section. Pockets or zones of wood shall not be placed in the fill or backfill.

2.2 EQUIPMENT

Compaction equipment shall be in accordance with Section 02330 EMBANKMENT FOR LEVEES, paragraph EQUIPMENT.

PART 3 EXECUTION

3.1 EXCAVATION

3.1.1 General

Excavation shall consist of removal and disposal of all materials of whatever nature encountered that may be necessary to excavate for structural foundations, pipe, trench and channels. Excavation may be performed by any reasonable methods which will produce the desired results. Excavation shall be performed to the lines, grades and sections indicated on the drawings or as otherwise required.

3.1.2 Excavation for Structure and Channels

The foundations for the structures shall be excavated to the lines and grades necessary for placement of formwork and concrete and that will insure stable slope conditions throughout the construction. The channels shall be excavated to the lines, grades and sections indicated on the drawings, within allowable tolerance of plus or minus 3 inches, as long as neither exist for more than 10 percent of the area. All foundations shall be on solid, undisturbed or properly compacted material. The bottom and side slopes of excavation upon or against which concrete or filters are to be placed shall be accurately finished to the dimensions prescribed and or directed, within allowable tolerance of +1/2 inches and -2 inches and plus or minus 2 inches for stone as long as neither exist for more than 10 percent of the area or 200 square feet. Where disturbed by the Contractor's operations and elsewhere as required, the excavated surfaces shall be moistened with water or dried as necessary and tamped or rolled with suitable tools or equipment for the purpose of thoroughly compacting them and forming firm foundations upon or against which to place the concrete or stone. Except for the permissible tolerance, over excavation will not be permitted except to remove unsuitable material as directed by the Contracting Officer, and the Contractor will not be paid for over excavating. Unauthorized over excavation shall be backfilled with approved materials, placed in layers not more than 4 inches in thickness, and thoroughly compacted by tamping or rolling to a density at least equal to that of the adjacent similar undisturbed material. This corrective work shall be at no additional cost to the Government.

3.1.3 Removal of Unsuitable Materials

If, at any point in the excavation for the structure, the foundation material below the lines indicated on the drawings is found to be unsuitable, it shall be removed to the depth directed by the Contracting Officer and replaced with approved material placed and compacted as specified above for backfill of over excavation. Payment for authorized over excavation and backfill of authorized over excavation will be made in accordance with the Contract Clause "CHANGES".

3.1.4 Disposal of Excavated Materials

Suitable materials removed from required excavation may be disposed of by placing directly into embankment fill, backfill, or by stockpiling for later use in embankment fill or backfill. Materials from structure which are not suitable for use as embankment fill or backfill, shall be disposed of in accordance with Section 02222 EXCAVATION FOR LEVEES, paragraph UNSUITABLE MATERIALS.

Stockpiles of materials temporarily stored for later use shall be located in areas approved by the Contracting Officer. Stockpiles shall be built up in layers not more than 2 feet in thickness. Stockpiled material shall have a maximum height not to exceed 10 feet, shall have end and/or side slopes not steeper than 1V on 2H, and the surfaces of all stockpiles shall be sloped to drain readily and sealed by compacting. Excavation from stockpiles shall be made so as to maintain drainage at all times. No stockpiled material shall be placed within 20 feet of top bank of inlet or outlet ditches as finally excavated. No material shall be stockpiled within 20 feet of top bank of structure excavation.

3.1.4.1 Disposal of Discarded Materials

Discarded material other than those which can be included in the solid waste category shall be disposed of as specified in paragraph EXCAVATION, subparagraph DISPOSAL OF EXCAVATED MATERIALS.

3.2 PLACEMENT

3.2.1 Backfill and Embankment

3.2.1.1 General

All fills and backfills associated with the concrete structure and road subgrade shall be placed as shown on the drawings. Fills and backfills associated with the ditches shall be placed as semicompacted fill. No backfill or fill shall be placed on any part of the foundation until such areas have been inspected and approved. Backfill or fill shall not be placed on or against concrete surfaces prior to 14 days after the placing of the concrete, except when otherwise approved or required by the Contracting Officer. No backfill or fill shall be placed on frozen surfaces and no frozen materials shall be placed in the backfill or fill. The foundation surface and any concrete surfaces shall be suitably moistened prior to placement of backfill against them. Unless otherwise directed, the backfill or fill shall be brought up and maintained at approximately the same level regardless of the number of types of material being placed. Materials shall be so placed that there is no mixing of the different types of materials in the backfill or fill.

3.2.1.2 Spreading

After dumping, the materials shall be spread by bulldozer or other approved means in approximately horizontal layers over the entire area under construction. During the dumping and spreading process, the Contractor shall remove all roots, trash and debris from the backfill materials. Semicompacted materials shall be placed in layers, the first layer not more than 6 inches in thickness and the succeeding layers not more than 1 foot thick prior to compaction with tamping rollers. Thickness of layers of structure backfill and clay blanket shall be placed in layers not more than 6 inches in thickness prior to compaction. Thickness of layers of pervious material shall not be greater than 9 inches. As soon as practicable after commencement of construction of any section of the backfill or fill, the surface shall be sloped to drain freely and shall be so maintained throughout construction. If the compacted surface of any layer of random material is determined to be too smooth to bond properly with the succeeding layers, it shall be loosened by harrowing or by other approved means before the succeeding layer is placed thereon. Ruts in the surface of any layer shall be filled before compacting additional materials.

3.3 COMPACTION

3.3.1 Semicompacted Embankment and Backfill

Semicompacted fill and random backfill shall be compacted in accordance with Section 02330 EMBANKMENT FOR LEVEES, paragraph SEMICOMPACTED EMBANKMENT.

3.3.2 Fully Compacted Embankment and Backfill

3.3.2.1 Impervious Backfill

After a layer of impervious backfill has been placed and spread, it shall be harrowed or disked, if required, to break up and blend the backfill materials, unless harrowing or disking is performed to obtain uniform moisture distribution. Harrowing or disking shall be performed with a spring-tooth harrow or other approved harrow or disk to the depth of the uncompacted layer. If one pass of the harrow or disk does not accomplish the breaking up and blending of the materials, additional passes of the harrow or disk may be required, but in no case will more than three passes of the harrow or disk on

any one layer be required for this purpose. When the moisture content and the condition of the layer is satisfactory, the lift shall be compacted to at least 95 percent of the maximum density as determined by ASTM D 698. Portions of the backfill or fill which are not accessible to the roller and portions within 2 feet shall be placed in 4 inch layers and compacted with power tampers to a degree equal to that obtained on the other portions of the compacted backfill or fill by rolling as specified. Dumping, spreading, sprinkling, and compacting may be performed at the same time at different points along a section when there is sufficient area to permit these operations to proceed simultaneously.

3.3.2.2 Pervious Backfill

Immediately after each layer of pervious backfill or fill material has been placed, spread and saturated, the entire surface of the layer shall be compacted by not less than four complete passes of the crawler-type tractor specified in paragraph BACKFILL AND EMBANKMENT and paragraph EQUIPMENT. A complete pass shall consist of one entire coverage of the layer by the threads of the tractor or the surface of the roller. Pervious backfill placed within 2 feet of concrete shall be placed in layers not more than 9 inches thick, shall be saturated by flooding and shall be compacted by use of approved small vibratory compactors to 85 percent relative density.

3.3.3 Filter Materials

Filter materials, sand and gravel, shall be compacted as specified in paragraph COMPACTION, subparagraph FULLY COMPACTED FILL AND BACKFILL, sub-subparagraph PERVIOUS BACKFILL.

3.3.4 Additional Compaction

If, in the opinion of the Contracting Officer, the desired compaction of any portion of the backfill, fill or embankment is not secured by the minimum number of passes specified, additional complete passes may be directed over the surface area of such designated portion until the desired compaction, as defined by the Contracting Officer, has been obtained, and an equitable adjustment in the contract price and time will be made in accordance with the Contract Clause "CHANGES".

3.4 MOISTURE CONTROL

3.4.1 General

The materials in each layer of the backfill or fill shall contain the quantity of moisture within the limits specified below or as directed by the Contracting Officer which is necessary to obtain the desired compaction as determined by the Contracting Officer.

3.4.2 Impervious Backfill

The impervious moisture content shall be as uniform as practicable throughout any one layer of backfill and clay blanket. The upper and lower limits of moisture content shall not be more than 3 nor less than 2 percentage points, respectively, from the optimum moisture content as determined by the Contracting Officer in accordance with ASTM D 698. The method of determining the moisture content shall be according to ASTM D 2216. Material that is too wet shall be spread on the backfill and permitted to dry, assisted by disking or harrowing, if necessary, until the moisture content is reduced to a value within the specified limits. When the material is too dry, the Contractor will be required to sprinkle each layer on the backfill. Harrowing or other approved methods will be required to work the moisture into the material until a uniform distribution of moisture is obtained. Water

applied on a layer of backfill shall be accurately controlled in quantity so that free water will not appear on the surface during or subsequent to rolling. Should too much water be added to any part of the backfill so that the material is too wet to obtain the desired compaction, the rolling and all work on that section of the backfill shall be delayed until the moisture content of the material is reduced to a value within the specified limits and such delay shall not be the basis for a claim. If it is impracticable to obtain the specified moisture content by wetting or drying the material on the backfill, the Contractor may be required to prewet or dry back the material at the source. If, in the opinion of the Contracting Officer, the top or contact surfaces of a partial backfill section becomes too dry or too wet to permit suitable bond between these surfaces and the additional backfill to be placed thereon, the Contractor shall loosen the dried or wet materials by scarifying or disking to such depths as may be directed by the Contracting Officer, shall dampen or dry the loosened material to an acceptable moisture content and shall compact this layer as provided in paragraph COMPACTION, to densities comparable to the underlying backfill or fill, at no additional cost to the Government.

3.4.3 Pervious Backfill

Pervious backfill shall be wetted by sprinkling after spreading for compaction and each layer shall be kept in a saturated condition during rolling. Sprinkling shall be done by approved methods. All connections in the water supply system shall be watertight. Jets shall not be directed at the backfill with such force that finer materials will be washed out. Pervious backfill materials shall be kept free of muddy water and surface runoff and any pervious backfill material which becomes contaminated shall be removed and replaced at no expense to the Government.

3.5 SLIDES

3.5.1 Embankment Slides

In the event of the sliding of any part of the embankment during construction or after completion, but prior to acceptance, the Contractor shall, upon written order of the Contracting Officer, cut out and remove the slide and then rebuild that portion of the embankment or as an alternative shall construct a stability berm of such dimensions and placed in such a manner as the Contracting Officer shall prescribe. In case the slide is caused through fault or negligence of the Contractor, the foregoing operations shall be performed without cost to the Government. In case the slide in the embankment is not caused through fault or negligence of the Contractor, the volume ordered removed from the embankment and volume replaced in the embankment will be paid for in accordance with the Contract Clause "CHANGES", in addition to any payment due the Contractor for materials previously placed. In either case, the method of slide correction will be determined by the Contracting Officer

3.5.2 Channel Slides

In case sliding occurs in any part of the prescribed excavation for the inlet or outlet channel during construction or after completion but prior to acceptance, the Contractor shall remove and repair such portions of the slides as the Contracting Officer may direct. In case the slide is caused through fault of the Contractor, the slide shall be removed and repaired without cost to the Government. In case the slide is not caused through fault of the Contractor, an equitable adjustment pursuant to the Contract Clause "CHANGES" will be made for removing and repairing the slide.

3.6 GRADE TOLERANCES

3.6.1 General

Embankments and fills shall be constructed to the lines and grades and sections indicated on the contract drawings. The following tolerances will be permitted above and below the design grades and cross sections provided that the areas drain and there are no abrupt bulges or depressions in surfaces and side slopes are uniform.

3.6.2 Embankments, Slopes and Structures

For the side slopes of the road embankment and fill areas adjacent to permanent structures, a vertical tolerance of plus or minus 2 inches will be permitted, except that neither extreme of such tolerance may be continuous over an area greater than 200 square feet and abrupt changes from one extreme to the other will not be permitted. The horizontal tolerance will be plus or minus 6 inches.

3.6.3 Channels

For the bottom elevation and side slopes of the channels, a vertical tolerance of plus or minus 6 inches from the grade indicated on the contract drawings will be permitted and shall present a neat, smooth surface, and shall be free from all obstructions.

3.7 FIELD TESTING CONTROL

Testing shall be the responsibility of the Contractor and shall be performed by an approved commercial testing laboratory or by the Contractor subject to approval. Field density and moisture content tests shall be performed on every 200 cubic yards of material placed. Field in-place density shall be determined in accordance with ASTM D 1556, ASTM D 2167, or ASTM D 2922. The calibration checks of both the density and moisture gages shall be made at the beginning of a job on each different type of material encountered and at intervals as directed. The Contractor shall submit three copies daily of control tests and reports as well as records of corrective action taken.

End of Section

DIVISION 2 - SITE WORK

SECTION 02222

EXCAVATION FOR LEVEES

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SECTION 02222

EXCAVATION FOR LEVEES

PART 1 GENERAL

1.1 DESCRIPTION

The work covered by this section consists of furnishing all plant, labor, materials, and equipment, and performing all operations necessary for stockpiling materials, removal of unsuitable material from embankment foundations and all other excavation incidental to the construction of embankments and berms, as specified herein or as shown on the drawings.

1.2 REFERENCES (Not Applicable)

1.3 QUALITY CONTROL

The Contractor shall establish and maintain quality control of excavation operations to assure compliance with contract requirements, and maintain detailed records for all construction operations.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION

3.1 EXCAVATION IN BORROW AREAS

3.1.1 General

The rights-of-way and earth materials for constructing the work will be furnished without cost to the Contractor, at locations specified herein and shown in the drawings.

3.1.1.1 Equipment

The Contractor shall provide the types of equipment as necessary to perform the required excavation according to the *in situ* conditions of the borrow area.

3.1.2 Borrow Areas

3.1.2.1 General

Borrow material is the suitable excavated material within the right-of-way of the New Madrid Pumping Station and the excavated embankment material from the St. John's Channel Enlargement, Item 3 project. Refer to Drawings G108 and G109 for locations of available borrow from the St. John's Channel Enlargement, Item 3.

3.1.2.2 Requirements

Borrow areas shall conform to requirements prescribed herein. The permissible excavation depths in the borrow areas will be specified by the Contracting Officer and as shown on the drawings from the St. John's Channel Enlargement project. But the right is reserved in accordance with the Contract Clause "CHANGES" to modify the permissible depths in accordance with subsurface conditions determined as work proceeds. The bottom of the areas excavated under this contract shall be dressed to the extent necessary to provide a reasonably smooth surface that can readily be traversed by a 50 to 60 horsepower farm tractor pulling a rotary-type pasture mower and sloped to provide surface drainage to the low side of the borrow area as soon as all usable materials have been removed or the Contractor has completed his use of the borrow area. Abrupt changes in grade shall be avoided. Unsuitable material wasted in the (borrow areas) shall be sloped to drain. Any excavation below the depths and slopes specified herein, or by the Contracting Office shall be backfilled by the Contractor, at his expense, to the specified permissible excavation line, with suitable material placed and compacted in accordance with Section 02330 EMBANKMENT FOR LEVEES, paragraph SEMICOMPACTED FILL. The borrow areas excavated under this contract shall be drained of water regardless of its source, including subsurface water, and kept free of water during excavation, as excavation will not be permitted in water nor shall excavated material be scraped, dragged or otherwise moved through water. Drainage of borrow areas shall be accomplished by ditching, sump pumping or other approved methods. The borrow areas excavated under this contract and inundated from high river stages shall be drained and allowed to dry to a workable condition as quickly as practicable after the high river stage has passed, Special Contract Requirements "RIGHTS-OF-WAY." To conserve arable land and make optimum use of available borrow, the excavation of the borrow areas shall be made continuous throughout the length of the borrow areas to the permissible borrow depths, to provide the required quantity of suitable material, and in such manner that all suitable available material within the borrow area will be utilized. The Contractor shall submit an excavation plan for approval by the Contracting Officer and shall not begin excavation until the Contracting Officer's approval has been received. The plan shall contain, as a minimum, the following:

- a. The Contractor's proposals for implementing Section 01130 ENVIRONMENTAL PROTECTION insofar as that section applies to borrow areas.
- b. The Contractor's proposed methods and required rights-of-way for draining and keeping the borrow areas free of water during excavation under this contract.
- c. The Contractor's proposed methods for draining borrow areas excavated under this contract which may be inundated by high river stages.
- d. The Contractor's proposals for conserving arable land and for making optimum use of available borrow, including the Contractor's proposed methods for smoothing the bottom of the borrow areas after having completed use of the borrow areas.

3.1.3 Disposal of Materials

3.1.3.1 Suitable Materials

Excavated materials which are suitable for incorporation in the levee embankment and berms, or other fills or backfill, shall either be placed directly therein, or stockpiled and subsequently used in the levee embankment and berms or other fills or backfill.

3.1.3.2 Unsuitable Materials

Materials from required excavation which, as defined in Section 02330 EMBANKMENT FOR LEVEES, paragraph UNSUITABLE MATERIALS, are unsuitable for levee embankment and berms or fill or backfill material will be ordered wasted and shall be disposed of in areas denoted by the Contracting Officer as disposal areas. The materials shall be shaped so that its surface is free from abrupt changes in grade and shall be sloped to drain. Where possible, unsuitable materials in borrow areas shall not be moved.

3.2 EXCAVATION IN OTHER AREAS

3.2.1 General

Excavation from other areas shall consist of removal of material in preparing the levee embankment foundations to the lines and grades shown on the drawings, removal of materials from ditches and channels, removal of material from structural excavation areas as specified in Section 02221 EXCAVATION, FILL, BACKFILL AND EMBANKMENT FOR STRUCTURES, and removal of unsuitable materials as defined in Section 02330 EMBANKMENT FOR LEVEES, paragraph UNSUITABLE MATERIALS. Whenever unsuitable foundation material is encountered, the unsuitable material shall be removed to the depth directed by the Contracting Officer. Care shall be exercised by the Contractor in excavating to the lines and grades shown and in removing unsuitable materials so as not to excavate below the grades specified or depth directed. Excavation below the lines and grades specified or the depth directed shall be backfilled by the Contractor at his expense. Such backfill shall be brought to grade with suitable material with each layer placed and compacted as specified in Section 02330 EMBANKMENT FOR LEVEES, paragraph SEMICOMPACTED FILL. Excavated materials shall be disposed of as specified in paragraph DISPOSAL OF MATERIALS.

3.2.2 Muck

Muck is fine-grained material that settles to the bottom of the stream. There are approximately 5 feet of this material on the bottom that has built up over the past several years. The actual depth is difficult to determine because density is graduated and varies with the depth. The Contractor is not required to move material unless it is in the work area. In areas where embankment is to be placed, the material shall be removed as part of surface preparation.

3.2.3 Channels

3.2.3.1 Excavation

Channels shall be excavated to the cross sections, lines, and grades shown on the drawings. Suitable material excavated from these ditches shall be used in the embankment(s). Any excess material or material unsuitable for use in the embankment as determined by the Contracting Officer shall be wasted and shall be disposed of as specified in paragraph UNSUITABLE MATERIALS at no additional cost to the Government. The right is reserved to require such other ditching as is deemed desirable and which can be performed without unreasonable difficulty by the equipment on the job. Suitable materials excavated from such ditching may, at the option of the Contractor, be used in the embankment. Materials not so used shall be wasted and shall be placed along the ditch banks as stated above.

3.2.3.2 Acceptance

Prior to the acceptance of the work, the Contracting Officer may require the excavation of sediments from channels and ditches as necessary to restore them to grade and section. Disposal of such material shall be as directed, and an equitable adjustment under the Contract Clause "CHANGES" will be made.

End of Section

DIVISION 2 - SITE WORK

SECTION 02330

EMBANKMENT FOR LEVEES

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SECTION 02330

EMBANKMENT FOR LEVEES

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS
(AASHTO)

- | | |
|--------------|---|
| AASHTO T 180 | (1993) Standard Method of Test for Moisture-Density Relations of Soils Using a 10-lb (4.54 kg) Rammer and an 18-In. (457 mm) Drop |
| AASHTO T 2 | (1991) Standard Methods of Sampling of Aggregates |
| AASHTO T 87 | (1986; Rev 1993) Standard Method for the Dry Preparation of Disturbed Soil And Soil Aggregate Samples for Test |

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- | | |
|-------------|--|
| ASTM C 136 | (1996)a Standard Method for Sieve Analysis of Fine and Coarse Aggregates |
| ASTM D 1556 | 90(1996)e1 Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method |
| ASTM D 2922 | (1996)e1 Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth) |
| ASTM D 422 | 63(1998) Standard Test Method for Particle-Size Analysis of Soils |
| ASTM D 4318 | (1998) Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils |
| ASTM D 698 | (1998) Laboratory Compaction Characteristics of Soil Using Standard Effort [12,400-ft-lbf/cu.ft. (600 kn-m/cu.m.)] |
| ASTM D 2216 | (1998) Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass |

CODE OF FEDERAL REGULATIONS (CFR)

29 CFR 1926 (1996) Safety and Health Regulations for Construction

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "SUBMITTAL PROCEDURES," in sufficient detail to show full compliance with the specification:

SD-07 Schedules; F10.

Construction Equipment List shall be submitted for all Major Equipment to be used. (Example: Compaction Equipment).

SD-09 Reports; F10.

Test Reports shall be submitted by the Contractor for Soil Test within three working days of test date. Soil test shall comply with paragraph entitled, "Quality Control Testing During Construction."

SD-13 Certificates; F10.

Certificates of Compliance for Proposed Soil Materials shall be submitted in accordance with paragraph entitled, "Tests for Proposed Soil Materials."

SD-18 Records; F10.

Records of Existing Conditions shall be submitted by the Contractor prior to the start of work. The Contractor shall verify the existing conditions are correct as shown on the plans and described in the specifications. The Contracting Officer shall be notified immediately if any discrepancies are found.

The records shall include the following:

- Location of Utilities
- Location of Tests
- Location of Inspections
- Location of Approved Utilities

1.3 DEFINITIONS

1.3.1 Soil Materials

Cohesionless soil materials include gravels, gravel-sand mixtures, sands, and gravelly sands. Moisture-density relations of compacted cohesionless soils when plotted on graphs will show straight lines or reverse-shaped moisture-density curves.

Cohesive soil materials include clayey and silty gravels, sand-clay mixtures, gravel-silt mixtures, clayey and silty sands, sand-silt mixtures, clays, silts, and very fine sands. Moisture density relations of compacted cohesive soils when plotted on graphs, will show normal moisture-density curves.

1.3.2 Subgrade

Subgrade shall mean the top surface of a backfill or fill or the uppermost surface of an excavation, graded to conform to the required subgrade elevation and compacted to densities indicated.

1.3.3 Degree of Compaction

Degree of compaction required is expressed as a percentage of the maximum density obtained by the test procedure in AASHTO T 180, Method B or D.

1.4 SAMPLING AND TESTING

1.4.1 Soil Testing and Inspection Service

Borrow materials shall be furnished by the government. A certified soil testing service approved by the Contracting Officer shall be provided by the Contractor. Testing shall include field-testing facilities for quality control during construction period.

1.4.2 Quality Control Testing During Construction

Soil materials shall be tested during construction as follows:

MATERIAL	REQUIREMENT	TEST METHOD	MATERIAL TESTED AND NUMBER OF TESTS
Soil material- in-place after compaction	Density of soil-in-place	ASTM D 1556 Sand Cone Method or ASTM D 2922 Nuclear Method	At least three daily for each subgrade soil material, and for each layer of soil material; additional test whenever there is any change in moisture

1.4.3 Evaluation of Test Results

Soil materials of any classification shall not have a moisture content at the time of compaction that would be classified as unsatisfactory soil materials in the paragraph entitled, "Definitions."

Results of density of soil-in-place tests shall be considered satisfactory if the average of any group of four consecutive density tests which may be selected is in each instance equal to or greater than the specified density, and if no density test has a value more than 2 percentage points below the specified density.

PART 2 PRODUCTS

2.1 EMBANKMENTS

2.1.1 General

The embankment for levees and cofferdam shall be constructed of earth obtained from the borrow areas and other required excavations as prescribed in Section 02222 EXCAVATION FOR LEVEES and to the extent shown on the drawings. The embankment shall be constructed of earth that is free from unsuitable and frozen materials as defined in paragraphs UNSUITABLE MATERIALS and FROZEN MATERIALS. Material classified by the Unified Soil Classification System (as shown on the Soil Boring Legend) as gravels (GW, GP, GM) and sands (SW, SP, SM) shall not be used unless suitably blended with less pervious material to the extent that it no longer classifies as these materials.

2.1.2 Unsuitable Materials

Materials which are classified as unsuitable for levee embankment or fill or backfill material are defined as masses of organic matter, sticks, branches, roots, and other debris.

2.1.3 Frozen Materials

Under no circumstances shall frozen earth, snow, or ice be placed in levee embankment or berm. The Contracting Officer may require the wasting of frozen material in order that construction may proceed.

2.2 EQUIPMENT

The following are equipment requirements for embankment construction.

2.2.1 Tamping Rollers

2.2.1.1 Tractor-Drawn

Tractor-drawn tamping rollers shall consist of one or more units. Each unit shall consist of a cylindrical drum not less than 60 inches in length and not less than 60 inches in diameter. Each drum shall have staggered feet uniformly spaced over the cylindrical surfaces so as to provide approximately 3 tamping feet for each 2 square feet of drum surface. The tamping feet shall be 7 to 11 inches in clear projection from the cylindrical surface of the roller, and shall have a face area of not less than 5 nor more than 1.0 square inches. The drums shall be water or sand and water ballasted. The weight of the roller when fully loaded shall not be less than 3,500 pounds per foot of drum length. The Contractor shall vary the amount of ballast in the drums to obtain optimum compaction effort for the material being compacted. The roller shall be equipped with cleaning devices, so designed and attached as to prevent the accumulation of material between the tamping feet. These cleaning devices shall be maintained at their full length and correct alignment throughout the periods of use of the roller. The rolling units of multiple-type tamping rollers shall be pivoted on the main frame in a manner which will permit the units to adapt themselves to uneven ground surfaces and to rotate independently. The roller shall be pulled by a tractor at a speed not to exceed 3.5 miles per hour.

2.2.1.2 Self-Propelled

At the option of the Contractor, self-propelled tamping rollers may be used in lieu of tractor-drawn tamping rollers provided these rollers conform to the towed roller requirements for the length and spacing of tamping feet, the empty weight per foot of drum, and cleaning devices. However, self-propelled rollers exceeding the empty weight requirement may be used, provided that by substitution of tamping feet having a face area not exceeding 14 square inches, the nominal foot pressure on the tamping feet of the self-propelled roller can be adjusted to approximate the foot pressure of the towed

roller for the particular working conditions. Self-propelled rollers conforming to the above requirements but with tamping feet exceeding the 14 square inch maximum face area may be approved for use provided the Contractor demonstrates to the satisfaction of the Contracting Officer by field tests performed in accordance with the provisions of paragraphs ALTERNATIVE COMPACTION EQUIPMENT that the roller can properly compact the fill without creating planes of weakness or laminations. For the self-propelled rollers in which steering is accomplished through the use of rubber-tired wheels, the tire pressure shall not exceed 40 psi. The roller shall be operated at a speed of not more than 3.5 miles per hour.

2.2.2 Rubber-Tired Rollers

Rubber tired rollers shall have a minimum of four wheels per axle equipped with pneumatic tires. The tires shall be of such size and ply as to be capable of being operated at tire pressures between 80 and 100 psi at 25,000 pound wheel load. The roller wheels shall be such that the distance between the nearest edges of adjacent tires is not greater than 50 percent of the rated tire width of a single tire. The roller shall have a rigid steel frame provided with body suitable for ballast loading so that the load per wheel may be varied, as directed by the Contracting Officer, from 18,000 to 25,000 pounds. The roller shall be towed at speeds not to exceed 5 miles per hour.

2.2.3 Crawler-Type Tractors

Crawler-type tractors used for spreading or compaction shall weigh not less than 20,000 pounds, shall exert a unit tread pressure of not less than 6 psi, and shall be operated at speeds not to exceed 3.5 miles per hour when being used for compaction. The tractor will not be considered to be compacting while spreading material.

2.2.4 Alternative Compaction Equipment

The Contractor may propose use of alternative types of compaction equipment not included in these specifications. The suitability of the alternative equipment must be demonstrated to the Contracting Officer by a field test conducted by and at the expense of the Contractor. The alternative compaction equipment must be capable of properly compacting the soil so that no planes of weakness or laminations are formed in the fill. The field test shall consist of compacting a minimum of three layers of an area of embankment with the alternative type equipment. Testing and inspection of the area shall then be performed by the Contractor at no additional cost to the Government. Procedures for constructing and testing the area will be provided by the Contracting Officer. Each proposed alternative type of equipment must be capable of compacting a layer of soil not less than 12 inches thick. A minimum of four complete passes over each layer of the test fill will be required for each type of alternative equipment that is allowed for use, unless in the course of constructing the test fill the Contractor is able to demonstrate that proper compaction can be obtained with fewer passes. Alternative type equipment shall be operated at speeds not to exceed 3.5 miles per hour. If sufficient previous testing has been performed on the alternative compaction equipment proposed by the Contractor to verify the suitability of the equipment to the Contracting Officer's satisfaction, the Contracting Officer may determine that the above-specified field test is not required.

2.2.5 Miscellaneous Equipment

Scarifiers, disks, spring-tooth or spike-tooth harrows, spreaders, power tampers, and other equipment shall be types suitable for construction of levee embankment and berms.

2.2.6 Sprinkling Equipment

Sprinkling equipment shall be designed to apply water uniformly and in controlled quantities to variable widths of surface.

PART 3 EXECUTION

3.1 FOUNDATION PREPARATION

3.1.1 General

After clearing and grubbing, the entire earth surface on or against which semicompacted or compacted fill is to be placed shall be thoroughly broken to a depth of 6 inches. If for any cause, this broken surface becomes compacted in such a manner that, in the opinion of the Contracting Officer, a plane of seepage or weakness might be induced, it shall again be adequately scarified before depositing material thereon. All scarifying and breaking of ground surface shall be done parallel to the centerline of the levee. All of the foregoing work shall be completed at least 200 ft in advance of the levee embankment construction.

3.1.2 Drainage

The foundation receiving fill, and all partially completed fill shall be kept thoroughly drained, except for the following:

- a. Drainage of foundation areas for landside and riverside berm will not be required; however, the Contractor may, at his option and expense, drain such foundation areas.
- b. Drainage to areas outside the right-of-way limits will be allowed only after the Contractor has obtained rights-of-way from the appropriate landowner for such drainage in accordance with Special Contract Requirement "RIGHTS OF WAY." (See Section 02222 EXCAVATION FOR LEVEES, paragraph BORROW AREAS.)

3.1.3 Frozen Ground

No fill shall be placed upon frozen ground.

3.2 LEVEE EMBANKMENT AND BERM CONSTRUCTION

3.2.1 Semicompacted Fill

3.2.1.1 General

The location and extent of the semicompacted fill shall be as shown on the drawings. Semicompacted fill shall not be placed in water. The materials for semicompacted fill shall be placed or spread in layers, the first layer not more than 6 inches in thickness and the succeeding layers not more than 12 inches in thickness prior to compaction. Layers shall be started full out to the slope stakes and shall be carried substantially horizontal and parallel to the levee centerline with sufficient crown or slope to provide satisfactory drainage during construction. Benching into the slope of the existing embankment is required in order to place and compact the material in horizontal layers. The vertical face of the existing embankment resulting from the benching operation shall be a minimum of 1 foot in height but shall not exceed 2 feet in height. When the surface of any compacted layer is too smooth to bond

properly with the succeeding layer, it shall be adequately scarified before the next layer is placed thereon.

3.2.1.2 Moisture Control

It is intended that the borrow material shall be placed in the embankment at its natural moisture content.

3.2.1.3 Compaction

When the moisture content and conditions of the spread layers are satisfactory, each layer shall be compacted by any of the following methods at the option of the Contractor:

a. Tamper-Type Roller

Four complete passes over each layer will be required. If tamping rollers are used in tandem, not more than two rows will be permitted, and in such case, one trip of the tandem rollers over any surface will be considered as two passes. When tamping rollers are used in tandem, the tamper foot spacing shall be offset so that the circumferential rows on the rear drums are in line with the midpoint of the circumferential rows of the forward drums. Each pass of the tamping roller shall overlap the preceding or adjacent pass by not less than 1 foot.

b. Rubber-Tired Roller

Two complete passes over each layer will be required.

c. Crawler-Type Tractor

Three complete passes over each layer will be required. The tractor will not be considered to be compacting while spreading materials.

3.2.1.4 Definition of Pass

A pass shall consist of one complete coverage of the surface of a layer by the treads of the roller, tractor, or other compacting equipment. Portions of the embankment which the compacting equipment cannot reach for any reason shall be compacted by an approved method to the density at least equal to that of the surrounding embankment.

3.2.1.5 Additional Compaction

If, in the opinion of the Contracting Officer, the desired compaction of any portion of the embankment cannot be secured by the minimum number of passes specified, additional complete passes shall be made over the surface area of such designated portion until the desired compaction has been obtained, and an equitable adjustment in the contract price and time will be made.

3.2.2 Compacted Fill

The compacted fill shall be located as shown on the drawings. Compacted fill shall be placed and spread in uniform layers not more than 8 inches in loose thickness for the full width of the cross

section. Layers shall be kept level by use of road graders, bulldozers, or by other approved methods. The entire surface of the embankment under construction shall be maintained in such condition that the construction equipment can travel on any part of any one section and at no time shall separate pieces of equipment be permitted to track each other. Ruts in the surface of any layer shall be filled satisfactorily before compacting. Each layer of fill material placed as outlined above shall be brought to within 5 percentage points of optimum moisture content for clay (CL and CH) and within 3 percentage points of optimum moisture content for silt (ML) prior to commencement of compaction. The optimum moisture content for each type of material shall be determined in accordance with ASTM D 698. The actual moisture content of the material to be placed shall, as often as necessary, be checked by the Contractor to assure that the moisture content is within the range specified above, or as directed by the Contracting Officer. This moisture content check shall be performed in accordance with ASTM D 2216 or ASTM D 2922. The Contractor may be required to discontinue all compaction operations until the moisture content of the fill has been adjusted. The Contractor shall perform the necessary work in moisture control to bring the borrow material within the moisture content range specified above. No additional payment will be made for any moisture control required in this paragraph. Each layer of the embankment shall be rolled for the full width of the cross section. The rolling shall continue until a density has been obtained not less than 95 percent of the maximum density for the soil used, as determined by ASTM D 698. Material shall be classified by the Unified Soil Classification System (as shown on the Soil Boring Legend on the drawings.)

3.2.3 Dressing

The entire embankment shall be brought to not less than the prescribed gross cross section, within allowable tolerance, at all points. Unreasonable roughness of surface shall be dressed out to permit turfing operations.

3.3 CROSS SECTIONS AND ZONING OF MATERIALS

3.3.1 Levee Embankment Sections

Unless otherwise specified, the dimensions and slopes shall conform to the applicable cross sections shown on the drawings, within allowable tolerance.

3.3.2 Zoning of Materials for Levee Construction

In general, the levee section, including berms shall be homogeneous; however, where materials of varying permeabilities are encountered in the borrow areas, the more impervious material shall be placed toward the riverside slope, and the more pervious material shall be placed toward the landside slope.

3.3.3 Berms

Berms shall be constructed at the locations and to the grade and cross section shown on the drawings.

3.4 ACCESS ROADS AND RAMPS

3.4.1 Access Roads

3.4.1.1 Location

Access roads shall be located and constructed as approved by the Contracting Officer. They shall be designed to maintain the intended traffic, to be free draining and shall be constructed by placement of fill as specified in paragraph SEMICOMPACTED FILL and shall be maintained in good condition throughout the contract period.

3.4.2 Ramps

3.4.2.1 General

Ramps shall be constructed at the locations shown on the drawings by placement of a fill as specified in paragraph SEMICOMPACTED FILL. Ramps shall be constructed only by adding material to the levee crown and slopes. Ramps shall have a 16 foot crown width, a grade not to exceed 10 percent and 1V on 4H side slopes.

3.4.2.2 Changes in Ramp Dimensions or Locations

The Contracting Officer reserves the right to modify the dimensions and/or shift the locations of the ramps, to eliminate ramp construction, and/or to order the construction of additional ramps at other locations. Any additional costs incurred by the Contractor for additional ramps or modified ramp dimensions will be paid for in accordance with the Contract Clause "CHANGES".

3.5 GRADE TOLERANCES

All embankments shall be constructed to the gross grade and cross section shown on the drawings. The toe of the embankment for the frontline levee enlargement is based on the net grade shown in the drawings. For semicompacted fill at all points, a tolerance of 0.3 feet and for compacted fill at all points, a tolerance of 0.3 feet above or below the prescribed gross grade and cross section shown will be permitted in the final dressing provided that the crown of the levee drains, there are no abrupt humps or depressions in surfaces or bulges in the width of the crown, and the side slopes are uniform. Any partial fill or temporarily stockpiled material placed within the gross section shall not exceed the gross grade or gross slopes of the embankment by more than 2 feet and shall have side slopes not steeper than 1V on 3H.

3.6 SLIDES

Should sliding occur in any part of the embankment during its construction, or after its completion, but prior to its acceptance, the Contractor shall upon written order of the Contracting Officer, either cut out and remove the slide from the embankment and then rebuild that portion of the embankment, or construct a stability berm of such dimensions, and placed in such manner, as the Contracting Officer shall prescribe. In case the slide is caused through the fault of the Contractor, the foregoing operations shall be performed at no additional cost to the Government. In case the slide is not the fault of the Contractor, the Contractor shall upon written order of the Contracting Officer, repair the slide by the methods stated above, with payment for this work determined by the provisions of contract clause CHANGES. The method of slide correction will be determined by the Contracting Officer.

End of Section

DIVISION 2 - SITE WORK

SECTION 02410

MECHANICALLY STABILIZED WALLS

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SECTION 02410

MECHANICALLY STABILIZED WALLS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS
(AASHTO)

AASHTO AGC-ARTBA-27 (1990) Subcommittee on New Highway Materials Task Force
27 Report, "In Situ Soil Improvement Techniques"

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 318/318R (1995) Building Code Requirements for Structural Concrete and
Commentary

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 123/A 123M (1997)ae1 Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel
Products

ASTM A 153/A 153M (1998) Zinc Coating (Hot-Dip) on Iron and Steel Hardware

ASTM C 31/C 31M (1998) Making and Curing Concrete Test Specimens in the Field

ASTM C 39 (1996) Compressive Strength of Cylindrical Concrete Specimens

ASTM C 172 (1990) Sampling Freshly Mixed Concrete

ASTM D 1752 84(1996)e1 Preformed Sponge Rubber and Cork Expansion Joint
Fillers for Concrete Paving and Structural Construction

ASTM D 1785 (1996)b Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules
40, 80, and 120

PRECAST/PRESTRESSED CONCRETE INSTITUTE (PCI)

PCI MnI-117 (1996) Manual for Quality Control for Plants and Production of
Architectural Precast Concrete Products

1.2 SYSTEM DESCRIPTION

The work covered by this section consists of furnishing all plant, labor, equipment, and materials, and performing all operations required for designing, furnishing and installing four mechanically stabilized walls as specified and shown. The design of the mechanically stabilized walls is the responsibility of the manufacturer and the Contractor.

1.2.1 Design Requirements

1.2.1.1 Precast Wall Panels

Precast wall panels shall be designed in accordance with ACI 318/318R, PCI Mnl-117, PCI Mnl-121, and paragraph DEFINITIONS.

- a. **Compressive Strength.** Acceptance of the concrete panels, with respect to compressive strength, will be determined on the basis of production lots as defined in paragraph DEFINITIONS. During the production of the concrete panels, the manufacturer will randomly sample the concrete in accordance with ASTM C 172. A single set of compressive strength samples, consisting of a minimum of four cylinders, will be randomly selected from every production lot. Two cylinders shall be cured in the same manner as the panels and tested at 28 days. Two cylinders shall be cured in accordance with ASTM C 31 and tested at 28 days. Compression tests shall be made on standard 6 inches by 12 inches test specimens prepared in accordance with ASTM C 31. Compressive strength testing shall be conducted in accordance with ASTM C 39. In the event that a production lot fails to meet the specified compressive strength requirements, the production lot shall be rejected.
- b. **Construction Tolerances.** All concrete panels shall be manufactured within the following tolerances;
 - (1) **Panel Dimensions.** Position of reinforcement connectors shall be within 1 inch of the locations shown on the approved plans. All dimensions of the concrete panels shall be within 3/16 inch of the dimensions shown on the approved plans.
 - (2) **Panel Squareness.** Squareness, as determined by the difference between the two diagonals, shall not exceed 1/2 inch.
 - (3) **Angular Distortion.** Angular distortion with regard to the height of the panel shall not exceed 1/8 inch in 5 feet.
- c. **Rejection.** Panels shall be subject to rejection because of failure to meet any of the requirements specified. Any of the following defects shall also be sufficient cause for rejection:
 - (1) Defects that indicate imperfect molding.
 - (2) Defects indicating honeycombed or open texture concrete.

- (3) Defects in the physical characteristics for the concrete, such as broken or chipped concrete.

The Contracting Officer shall determine whether spalled, honeycombed, chipped, or otherwise defective concrete shall be repaired or be cause for rejection. Repair of concrete, if allowed, shall be done in a manner satisfactory to the Contracting Officer. Repair to concrete surfaces, which will be exposed to view after completion of construction, shall be approved by the Contracting Officer. Any repairs of panels shall be at no additional cost to the Government.

- d. Marking. The date of manufacture, the production lot number, and the piece-mark shall be clearly scribed on the rear face of each panel.

1.2.1.2 Mechanically Stabilized Walls

The internal stability design, external stability design, global stability design, and construction of the mechanically stabilized walls shall be the responsibility of the Contractor. All design data and computations shall be signed by a registered professional engineer and shall be submitted in accordance with paragraph SUBMITTALS. The professional engineer may be an employee of the manufacturer. The mechanically stabilized wall facing and reinforcement shall be similar and equal to the product of a recognized manufacturer regularly engaged in the production of mechanically stabilized walls. The wall shall have a uniform vertical face of modular concrete units or panels and shall be internally stabilized by soil reinforcement. The internal stability design shall be performed by the professional engineer and shall consider earth pressure, seepage pressure, drainage and pullout of soil reinforcement. The width of the stabilized mass, from the back of the wall to the end of the reinforcement, when completed, shall be no less than 0.7 times the wall height. A concrete leveling footing shall be provided. The centroid of the wall shall be located over the footings. The mechanically stabilized wall shall be designed and constructed for a life in excess of 75 years, and the designer/manufacturer is responsible for both internal, external and global stability of the wall, regardless, for the design life of 75 years. The mechanically stabilized wall shall be designed by established theories of soil mechanics and by published methods supported by experimental data. The size and weight of the prefabricated components shall permit easy handling in the field, and the maximum size and weight of any component shall be suitable for transportation by commercial carrier.

- a. Loadings. The mechanically stabilized wall shall be designed to withstand surcharge loads shown on the plans. Water shall be assumed to be at any height in the canal (including a no water case and an inundated case) and 3 feet higher behind the wall than on the front side. The mechanically stabilized wall shall also be designed to withstand earthquake loads based on a pseudo-static coefficient of 0.15 g.
- b. Internal Stability. The soil mass shall be designed considering a theoretical failure surface. The failure plane may be established by acceptable theories of soil mechanics or by published experimental data. The soil reinforcement shall extend a sufficient length beyond the failure surface to ensure that failure will not occur due to soil reinforcement pullout. The pull-out resistance shall consider only the length of the reinforcement located in the resistive zone and shall provide a factor of safety not less than 1.5 considering a maximum horizontal movement of the soil reinforcement of 0.75 inch deflection based on an angle of friction between the soil reinforcement and the soil particles. The length of the soil reinforcing system as measured from the back of the wall to the end of the soil stabilized mass shall be uniform from top to bottom of the

mechanically stabilized wall at any cross section. Properties of the reinforced fill as regards to soil strength shall be as shown on the plans.

- c. Drainage. The mechanically stabilized wall shall be designed to allow for proper drainage. A conventional drainage system along with an adequate vertical drainage system behind the wall shall be designed to allow water to drain through, around, and/or under the wall to prevent pore water pressure from developing behind the wall in excess of the pore water pressure for which the wall has been designed.

1.2.1.2.1 Quality Control

Supervisory personnel shall be provided who are thoroughly experienced in mechanically stabilized walls. No work shall commence until the mechanically stabilized wall Contractor and supervisor have been approved. A bidder who submits false, incorrect or incomplete data, or does not provide the required experience described above, will not be approved.

- a. The work of this section is specialized. The Contractor performing this work shall be a reputable firm regularly engaged in the design and performance of mechanically stabilized walls. He shall have successfully completed at least five projects within the last five years of similar size and complexity in this type of installation in similar subsurface and hydraulic conditions with a minimum of 5 to 10 years design experience.
- b. The Contractor shall complete and submit copies of the Statement of Qualification forms provided herein to identify the design consultant and owner for each referenced project for which this type of work was performed. The Contractor shall provide proof to the Contracting Officer of each project no later than 15 days after Notice to Proceed. Such evidence shall include the name and location of the project, client name and address and the name and telephone number of a representative of the consultant and contracting office for whom the work was performed and who can attest to successful completion of the work.
- c. A project summary shall be included for each referenced project. The project summary shall contain the start date and completion date of the project, total contract amount for the mechanically stabilized wall, and a detailed description of the project, site conditions and subsurface conditions.
- d. Assign an experienced, full-time supervisor, who has been in responsible charge of supervising mechanically stabilized wall for a least five projects in the last five years. The supervisor shall be present at the work site at all times during mechanically stabilized wall operations. Provide written verification of the supervisor's experience.

1.3 DEFINITIONS

1.3.1 Mechanically Stabilized Wall

Mechanically stabilized wall refers to a method of soil reinforcement, retention, and stabilization which is composed of precast panel facing, a leveling footing, and an area behind the facing composed of alternating layers of soil and soil reinforcement.

1.3.2 Wall

Wall refers to that element of the mechanically stabilized wall that consists of vertically aligned precast panel facing placed on a concrete leveling footing.

1.3.3 Fill

Fill is that region of soil adjacent to the precast panel facing which is reinforced. The term fill in this section shall constitute the mechanically stabilized wall fill material.

1.3.4 Soil Reinforcement

Soil reinforcement refers to the horizontal layers of galvanized reinforcement strips or mesh, or geosynthetic reinforcement, geogrid or woven geotextile in the fill.

1.3.5 Reinforcement Connector

Reinforcement connector refers to the galvanized or geosynthetic reinforcement bars or pins cast into the wall units or panels to which the soil reinforcement is attached.

1.3.6 Fasteners

Fasteners refer to the galvanized bolts and nuts or PVC pipe used to secure the soil reinforcement to the reinforcement connectors.

1.3.7 Manufacturer

Manufacturer refers to a recognized manufacturer regularly engaged in the production of mechanically stabilized walls using precast wall panels.

1.3.8 Production Lot

Production lot is defined as a group of panels that will be represented by a single set of compressive strength samples and will consist of either 40 panels or a single day production, whichever is less.

1.4 SUBMITTALS

Government approval is required for submittals with a “GA” designation; submittals having an “FIO” designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Design Data and Computations; FIO.

Within 30 days after receipt of Notice to Proceed, submit appropriate design data and computations to substantiate the design and sizing of the mechanically stabilized walls.

Joint Cover; FIO. Joint Filler; FIO

Submit descriptive data for the joint cover and joint filler.

Insurance; FIO.

Submit a copy of the precast wall panel manufacturer's Certificate of Insurance indicating a minimum of \$1,000,000 Errors and Omission coverage for final design engineering.

SD-04 Drawings

Shop Drawings; FIO

Within 30 calendar days after receipt of Notice to Proceed, the Contractor shall submit complete shop drawings of the mechanically stabilized walls. Detailed drawings shall include all details, dimensions, quantities and cross sections necessary to construct the mechanically stabilized walls.

SD-09 Reports

Concrete Mixture Proportions; FIO.

Ten days prior to placement of concrete, submit the mixture proportions that will produce concrete of the quality required. Submit applicable test reports to verify that the concrete mixture proportions selected will produce concrete of the quality specified.

Tests; FIO

Submit copies of all tests performed to ensure contract compliance.

SD-13 Certificates

Cement; FIO.

In accordance with Section 00800 SPECIAL CONTRACT REQUIREMENTS, paragraph CERTIFICATES OF COMPLIANCE, submit a Certificate of Compliance attesting that the materials comply with the specifications. Submit copies of all test results performed to ensure contract compliance. Acceptance will be based upon the Certificate of Compliance, accompanying test reports, and visual inspection by the Contracting Officer.

SD-14 Samples

Soil Reinforcement; FIO. Joint Filler; FIO. Joint Cover; FIO. Fasteners; FIO. Connectors; FIO.

Submit material samples of each type of the soil reinforcement, joint cover and filler, fastener, and connector. The soil reinforcement samples shall consist of: one 12 inch long and full width piece of reinforcing strip; one square foot piece of reinforcing mesh; or one square foot piece of geosynthetic reinforcement. The joint cover and joint filler sample shall be a minimum of 9 inches long and full width.

1.5 DRAWINGS, DESIGN DATA AND COMPUTATIONS

Complete shop drawings shall include all details, dimensions, quantities, and cross sections necessary to construct the mechanically stabilized walls and shall include but not be limited to the following items:

- a. A plan and elevation sheet or sheets for each mechanically stabilized wall shall contain the following:
 - (1) An elevation view of the wall, at its maximum height, shall indicate the elevation at the top of the wall and at all horizontal and vertical break points; all steps in the concrete leveling footings; the dimensions of the precast panels; the length of the horizontal soil reinforcement from the face of the wall; the type, size and location of the soil reinforcement; the distance along the face of the wall to where changes in length of the soil reinforcement occur; an indication of the original and final ground lines.
 - (2) A plan view of the mechanically stabilized wall that indicates the offsets from the construction centerline to the face of the wall at all changes in horizontal alignment, and limit of longest soil reinforcement extending from the wall.
 - (3) All general notes required for the wall construction.
 - (4) A listing of the summary of quantities shall be provided on the elevation sheet of each wall.
- b. All details for the concrete leveling footings shall be provided including all dimensions necessary for construction and the connection between the leveling footings and the bottom of the concrete panels. Details shall also be provided to show all dimensions necessary to construct the concrete panels including all reinforcing steel in each concrete panel and the location of reinforcement connectors embedded in the concrete panels.

1.6 DELIVERY, STORAGE, AND HANDLING

Materials shall be delivered to the site in a dry and undamaged condition and stored out of contact with ground.

1.6.1 Precast Wall Panels

Precast wall panels shall be handled, stored, and shipped in such manner as to eliminate the danger of chipping, discoloration, cracks, fractures and excessive bending stresses. The panels shall be stored in a manner specified by the manufacturer and in a flat area. Panels shall be marked with shop drawing identification.

1.6.2 Geosynthetic Reinforcement

The Contractor shall check the geosynthetic reinforcement upon delivery to ensure that the proper material has been received. Geosynthetic reinforcement shall be stored at temperatures above -20°F and below 140°F. The Contractor shall prevent excessive mud, wet cement, epoxy, and like materials, which may affix themselves to the geosynthetics from coming in contact with the geosynthetic material. Rolled geosynthetic material may be laid flat or stood on end for storage. The soil reinforcement or rolls shall not be dropped or dragged.

1.6.3 Soil Reinforcement

Soil reinforcement shall be transported with care and stored above the ground on wooden or padded supports. The soil reinforcement or bundles shall not be dropped or dragged.

PART 2 PRODUCTS

2.1 WALL

2.1.1 Precast Wall Panels

2.1.1.1 General

The size and weight of precast wall panels shall permit easy handling in the field, and the maximum size and weight of any components shall be suitable for transportation by commercial carrier. Concrete shall meet the requirements of SECTION 03301 CAST-IN-PLACE STRUCTURAL CONCRETE, except as follows. Reinforcement connectors, connecting pins, and lifting and handling device shall be on the approved plans prior to casting. The concrete wall panels may be shipped after reaching compressive strength.

2.1.1.2 Curing

The concrete panels shall be cast on a flat area, the front face of the form at the bottom, the back face at the upper part. Reinforcement connectors shall be set in the back face of the panels. The concrete in each unit shall be placed without interruption and shall be consolidated by the use of an approved vibrator, supplemented by such hand-tamping as may be necessary to force the concrete into the corners of the forms and prevent the formation of stone pockets, air bubbles, or cleavage planes. Clear form oil of the same manufacturer shall be used throughout the casting operation.

The Contractor shall give at least seven days notice prior to casting so that the Government can have QA personnel at casting site to view operations. Production shall not be delayed if Government QA not present after seven days.

2.2 SOIL REINFORCEMENT

2.2.1 Steel or Mesh Reinforcement

If steel is selected all fasteners and miscellaneous hardware shall be galvanized in accordance with ASTM A 123 or ASTM A 153 whichever applies to the type of item being galvanized. The design of the soil reinforcement shall consider the electrochemical properties of the backfill and any water which will be in contact with the soil reinforcement. These properties shall include resistivity, pH, chlorides, and sulfates. The soil reinforcement, reinforcement connectors, and fasteners shall be made of the type and grade material and to the dimensions recommended by the manufacturer in their published specifications. All soil reinforcement, reinforcement connectors, and fasteners shall be carefully inspected to ensure they are true to size and free from defects that may impact their strength and durability.

2.2.2 Geosynthetic Reinforcement

If geosynthetic reinforcement is selected, the soil reinforcement and reinforcement connectors, shall be geosynthetic material and shall be in accordance with the recommendations of AASHTO AGC-

ARTBA-27, Chapter Title, “Use of Extensible Reinforcement (Geosynthetic) for Mechanically Stabilized Earth Walls in Permanent Applications.” In the absence of long-term credible data, the default values recommended by AASHTO AGC-ARTBA-27, Chapter Title, “Use of Extensible Reinforcement (Geosynthetic) for Mechanically Stabilized Earth Walls in Permanent Applications” shall be used. Fasteners shall be determined by the designer.

2.2.3 Joint Filler

When required by shop drawings, joint filler for inclined, vertical, or horizontal joints between panels shall be the type material recommended by the manufacturer in their published specification. Joint filler for joints between the pumping station and the mechanically stabilized wall panels shall be expansion joint material conforming to ASTM D 1752, Type I, preformed sponge rubber.

2.2.4 Joint Cover

Cover for vertical, inclined or horizontal joints between panels and for joints between the mechanically stabilized wall panels and the pumping station wall shall be a nonwoven engineering fabric with a minimum grab tensile strength of 240 psi and a puncture strength of 140 psi. The width of the strips shall be 2 feet minimum. The Contractor shall follow all engineering fabric manufacturer’s guidelines including but not limited to storage, placement, handling and exposure to sun. Adhesive used to attach the fabric material to the rear of the facing panels shall be adhesive recommended by the engineering fabric manufacturer and approved by the Contracting Officer.

2.2.5 Fill Material

Fill material shall be in accordance with the wall manufacturer’s recommendations.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Wall Excavation

Excavation shall be performed as specified in SECTION 02221 EXCAVATION, FILL, BACKFILL AND EMBANKMENT FOR STRUCTURES.

3.1.2 Foundation Preparation

The foundation for the structure shall be graded level for a width equal or exceeding the length of the soil reinforcement plus 1 foot or as denoted on the shop drawings. Prior to construction of the mechanically stabilized wall, the foundation preparation shall be as specified in SECTION 02221 EXCAVATION, FILL, BACKFILL AND EMBANKMENT FOR STRUCTURES.

3.1.3 Concrete Leveling Footing

At each wall facing panel or unit foundation level an unreinforced concrete leveling footing shall be provided as shown in the shop drawings. The minimum leveling footing shall be a minimum of 12 inches thick and cured a minimum of 3 days before placement of wall panels or units. The concrete mixture for the footings shall meet the requirements of SECTION 03301 CAST-IN-PLACE STRUCTURAL CONCRETE.

3.2 ERECTION

Erection shall be in accordance with the approved erection instruction and plans, the requirements herein, and the manufacturer's published erection guidelines.

3.2.1 Precast Wall Panels

The first row of wall panels shall be aligned using holes cast into the panels. For erection, panels are handled by means of a lifting device set into the upper edge of the panels. Panels shall be erected to the location and elevations outlined in the construction drawings. The panels shall be temporarily braced during erection and the bracing shall remain in place until the fill behind the panels reaches a minimum height of 2/3 of the wall height. As fill material is placed behind the panels, the panels shall be maintained in position by means of clamps placed at the junction of adjacent panels, temporary wedges, or bracing according to the manufacturers published specification. Soil reinforcement shall be placed normal to the face of the wall, unless otherwise shown on the approved plans or directed by the Contracting Officer.

3.2.2 Backfill Placement

Backfill placement shall closely follow erection of each course of panels. Backfill shall be placed in such a manner as to avoid any damage or disturbance to the wall materials or misalignment of the facing panels. Any wall materials which become damaged or disturbed during backfill placement shall be either removed and replaced at the Contractor's expense or corrected as directed by the Contracting Officer. Any backfill material placed within the reinforced soil mass which does not meet the requirements of this specification shall be corrected or removed and replaced at the Contractor's expense, as directed by the Contracting Engineer.

Backfill shall be compacted to 95% of the maximum standard proctor density.

The moisture content of the backfill material prior to and during compaction shall be uniformly distributed throughout each layer. Backfill materials shall have a placement moisture content less than or equal to the Optimum Moisture Content. Backfill material with a placement moisture content in excess of the Optimum Moisture shall be removed and reworked until the moisture content is uniformly acceptable throughout the entire lift.

The maximum lift thickness after compaction shall not exceed 10 inches, regardless of the vertical spacing between layers of soil reinforcements. The Contractor shall decrease this lift thickness if necessary, to obtain the specified density. Prior to placement of the soil reinforcements, the backfill elevation, after compaction, shall be 2 inches above the attachment device elevation from a point approximately 12 inches behind the back face of the panels to the free end of the soil reinforcements, unless otherwise shown in the plans.

Compaction within 3 feet of the back face of the panels shall be achieved by at least three (3) passes of a lightweight mechanical tamper, roller or vibratory system. The specified lift thickness shall be adjusted as warranted by the type of compaction equipment actually used, but no soil density tests need to be taken within this area. Care shall be exercised in the compaction process to avoid misalignment of the panels or damage to the attachment devices. Heavy compaction equipment shall not be used to compact backfill within 3 feet of the wall face.

At the end of each day's operation, the Contractor shall slope the last level of backfill away from the facing to rapidly direct runoff of rainwater away from the wall face. In addition, the Contractor shall not allow surface runoff from adjacent areas to enter the wall construction site.

3.2.3 Soil Reinforcement

Soil reinforcement shall be laid horizontally on compacted wall fill, connected to the reinforcement connectors embedded in the precast wall panel, and pulled and anchored taut before wall fill is placed on the soil reinforcement. Slack in the soil reinforcement to wall facing reinforcement connectors shall be removed with tensioning devices in a manner, and to such a degree as approved by the manufacturer's representative.

3.2.4 Tolerance

All concrete face panel shall be erected within the following tolerances:

- a. Vertical tolerance (plumbness) and horizontal alignment tolerance shall not exceed 0.75 inch when measured along a 10 foot straight edge.
- b. The maximum allowable offset in any panel joint shall be 0.75 inch.
- c. The overall vertical tolerance of the wall (plumbness from top to bottom) shall not exceed 0.5 inch per 10 feet of wall height.

3.3 MANUFACTURER'S FIELD SERVICE

A field representative from the manufacturer shall be available during erection of the walls.

3.4 FIELD REPAIR

The Contractor shall be required to field repair damaged areas of the reinforcement and reinforcement connectors, and to replace soil reinforcement exhibiting damage. Field repair shall not be allowed on soil reinforcement which has been severely damaged. The Contracting Officer shall be solely responsible for determining the severity of damaged areas for purposes of repair or replacement. A soil reinforcement strip or mesh determined by the Contracting Officer to be severely damaged shall be removed from the work site and replaced with a new soil reinforcement strip or mesh at no additional cost to the Government.

3.5 TESTS, INSPECTIONS AND VERIFICATIONS

The Contractor shall perform tests as applicable to ensure contract compliance. Acceptance of the work under this section will be based upon the submittals required by paragraph SUBMITTALS and the visual inspection by the Contracting Officer.

End of Section

DIVISION 2 - SITE WORK

SECTION 02411

METAL SHEET PILING

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End of Section Table of Contents

SECTION 02411

METAL SHEET PILING

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 6/A 6M (1996b) General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling

ASTM A 328/A 328M (1993a: R1996) Steel Sheet Piling

FEDERAL SPECIFICATIONS (FS)

FS SS-C-153C (Rev. C) Cement, Bituminous, Plastic

1.2 SUBMITTALS

Government approval is required for all submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-04 Drawings

Metal Sheet Piling; FIO.

Detail drawings for sheet piling shall show complete piling dimensions and details, driving sequence and location of installed piling. Detail drawings shall include details and dimensions of templates and other temporary guide structures for installing piling. Detail drawings shall provide details of the method of handling piling to prevent permanent deflection, distortion or damage to piling interlocks.

SD-07 Schedules

Pile Driving Equipment; GA.

Complete descriptions of sheet piling driving equipment including hammers, extractors, protection caps and other installation appurtenances shall be submitted for approval prior to commencement of work.

SD-08 Statements

Pulling and Redriving; GA.

The proposed method of pulling sheet piling shall be submitted and approved prior to pulling any piling.

SD-09 Reports

Interlocked Joint Strength; GA.

The Contracting shall furnish a certificate showing that piling furnished has the required interlock strength as determined by test results of two representative test specimens, approximately 3 inches long, per heat.

Materials Tests; FIO.

Certified materials tests reports showing that sheet piling and appurtenant metal materials meet the specified requirements shall be submitted for each shipment and identified with specific lots prior to installing materials. Material test reports shall meet the requirements of ASTM A 6/A 6M.

SD-18 Records

Driving; FIO.

Records of the sheet piling driving operations shall be submitted after driving is completed. These records shall provide a system of identification which shows the disposition of approved piling in the work, driving equipment performance data, piling penetration rate data, piling dimensions and top and bottom elevations of installed piling.

1.3 DELIVERY, STORAGE AND HANDLING

Materials delivered to the site shall be new and undamaged and shall be accompanied by certified test reports. The manufacturer's logo and mill identification mark shall be provided on the sheet piling as required by the referenced specifications. Sheet piling shall be stored and handled in the manner recommended by the manufacturer to prevent permanent deflection, distortion or damage to the interlocks. Storage of sheet piling should also facilitate required inspection activities.

PART 2 PRODUCTS

2.1 METAL SHEET PILING

Steel for sheet piling shall conform to the requirements of ASTM A 328. Sheet piling shall be of the type indicated on the drawings, have a nominal web thickness of not less than 3/8 inch and be of a design such that when in place they will be continuously interlocked throughout their entire length. All piling shall be provided with standard pulling holes located approximately 4 inches below the top of the pile, unless otherwise shown or directed. Piling shall have the properties equivalent to those listed in the following table:

PROPERTIES OF SECTIONS

	Section Modulus Per Lin. Ft. of wall(In-cu)	Minimum Interlock Strength in Tension (Lbs Per Lin In)
PS 27.5	2.0	16,000

Cold-rolled sections with equivalent properties may be used.

2.2 TESTS, INSPECTIONS, AND VERIFICATIONS

Requirements for material tests, workmanship and other measures for quality assurance shall be as specified and in Section 05101 METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS.

2.2.1 Materials Tests

Materials tests shall conform to the following requirements. Sheet piling and appurtenant materials shall be tested and certified by the manufacturer to meet the specified chemical, mechanical and section property requirements prior to delivery to the site. Testing of sheet piling for mechanical properties shall be performed after the completion of all rolling and forming operations. Testing of sheet piling shall meet the requirements of ASTM A 6/A 6M.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Pile Driving Equipment

Pile driving equipment shall conform to the following requirements.

3.1.1.1 Driving Hammers

Hammers shall be steam, air, or diesel drop, single-acting, double-acting, differential-acting, or vibratory type. The driving energy of the hammers shall be between 3,000 and 10,000 foot-pounds as recommended by the manufacturer for the piling weights and subsurface materials to be encountered.

3.1.2 Placing and Driving

3.1.2.1 Placing

Any excavation required within the area where sheet pilings are to be installed shall be completed prior to placing sheet pilings. Pilings shall be carefully located as shown. Pilings shall be placed plumb with out-of-plumbness not exceeding 1/8 inch per foot of length and true to line. Temporary wales, templates, or guide structures shall be provided to insure that the pilings are placed and driven to the correct alignment. At least one template shall be used in placing each piling and the maximum spacing of templates shall not exceed 20 feet. Pilings properly placed and driven shall be interlocked throughout their length with adjacent pilings to form a continuous diaphragm throughout the length or run of piling wall.

3.1.2.2 Driving

Pilings shall be driven with the proper size hammer and by approved methods so as not to subject the pilings to damage and to ensure proper interlocking throughout their lengths. Driving hammers shall be maintained in proper alignment during driving operations by use of leads or guides attached to the hammer. A protecting cap shall be employed in driving when using impact hammers to prevent damage to the tops of pilings. Pilings damaged during driving or driven out of interlock shall be removed and replaced at the Contractor's expense. Adequate precautions shall be taken to insure that pilings are driven plumb. Pilings in each run or continuous length of piling wall shall be driven alternately in increments of depth to the required depth or elevation. No piling shall be driven to a

lower elevation than those behind it in the same run except when the pilings behind it cannot be driven deeper. If the piling next to the one being driven tends to follow below final elevation it may be pinned to the next adjacent piling. If obstructions restrict driving a piling to the specified penetration the obstructions shall be removed or penetrated with a chisel beam. If the Contractor demonstrates that removal or penetration is impractical the Contractor shall make changes in the design alignment of the piling structure as directed to insure continuity of the cut-off wall. Pilings shall be driven to depths shown and shall extend up to the elevation indicated for the top of pilings. A tolerance of 2 inches above the indicated top elevation will be permitted. Pilings shall not be driven within 100 feet of concrete less than 7 days old.

3.1.3 Cutting-Off and Splicing

Pilings driven to refusal or to the point where additional penetration cannot be attained and are extending above the required top elevation in excess of the specified tolerance shall be cut off to the required elevation. Pilings driven below the required top elevation and pilings damaged by driving and cut off to permit further driving shall be extended as required to reach the top elevation by splicing when directed at no additional cost to the Government. Pilings adjoining spliced pilings shall be full length unless otherwise approved. The tops of pilings excessively battered during driving shall be trimmed when directed at no cost to the Government. Piling cut-offs shall become the property of the Contractor and shall be removed from the site.

3.1.4 Inspection of Driven Piling

The Contractor shall inspect the interlocked joints of driven pilings extending above ground. Pilings found to be out of interlock shall be removed and replaced at the Contractor's expense.

3.1.5 Pulling and Redriving

In the pulling and redriving of piles as directed, the Contractor shall pull selected pilings after driving to determine the condition of the underground portions of pilings. Any piling so pulled and found to be damaged to the extent that its usefulness in the structure is impaired shall be removed and replaced at the Contractor's expense. Pilings pulled and found to be in satisfactory condition shall be redriven when directed.

3.2 REMOVAL

3.2.1 Pulling

The method of pulling piling must be approved. Pulling holes shall be provided in pilings as required. Extractors shall be of suitable type and size. Care shall be exercised during pulling of pilings to avoid damaging piling interlocks and adjacent construction. If the Contracting Officer determines that adjacent permanent construction has been damaged during pulling the Contractor will be required to repair this construction at no cost to the Government. Pilings shall be pulled one sheet at a time. Pilings fused together shall be separated prior to pulling unless the Contractor demonstrates to the satisfaction of the Contracting Officer that the pilings cannot be separated.

3.2.2 Treatment of Pile Tops

The surface of the piling wall embedded in concrete shall be coated using a bituminous material conforming to the requirements of FS SS-C-153C, Type I, Class A or B.

End of Section

DIVISION 2 - SITE WORK

SECTION 02542

STONE PROTECTION

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SECTION 02542

STONE PROTECTION

PART 1 GENERAL

1.1 SCOPE

The work provided for herein consists of furnishing all plant, labor, equipment and materials, and performing all operations in connection with the construction of the stone protection, including foundation preparation, placement of filter material, and placement of riprap, all in accordance with these specifications and the contract drawings.

1.2 QUALITY CONTROL

The Contractor shall establish and maintain quality control for all stone protection testing and operations to assure compliance with contract requirements, and shall maintain records of the quality control for all construction including but not limited to the following:

- (1) Foundation preparation (line and grade).
- (2) Inspection at the worksite to ensure use of specified materials.
- (3) Filter gradation and placement.
- (4) Riprap gradation and placement.

A copy of these records of inspections and tests, as well as the records of corrective action taken, shall be furnished the Government.

1.3 APPLICABLE PUBLICATION

The following publication of the issue listed below, but referred to thereafter by basic designation only, forms a part of this specification to the extent indicated by the reference thereto:

U.S. ARMY CORPS OF ENGINEERS, HANDBOOK FOR CONCRETE AND CEMENT (CRD)

CRD-C 106-93

Unit Weight and Voids in Aggregate

CRD-C 107-94

Specific Gravity and Absorption of Coarse Aggregate

PART 2 PRODUCTS

2.1 FILTER MATERIALS

2.1.1 General

Filter material shall consist of gravel or crushed stone. The material shall be composed of tough, durable particles, shall be reasonably free from thin, flat and elongated pieces, and shall contain no organic matter nor soft, friable particles in quantities considered objectionable by the Contracting Officer.

2.1.2 Gradation

U.S. Standard <u>Sieve No.</u>	Permissible Limits <u>Percent by Weight, Passing</u>
3-inch	100
1 1/2-inch	85-100
3/4-inch	35-70
3/8-inch	5-40
No. 4	0-10

The material shall be well-graded between the limits shown. The Contractor shall furnish a certified test report which certifies that the supplied filter material meets the above gradation and also furnish a representative sample of this same material to the Government.

2.2 STONE

2.2.1 General

All stone shall be durable material as approved by the Contracting Officer. The sources from which the Contractor proposes to obtain the material shall be selected well in advance of the time when the material will be required. In case an undeveloped source is to be used, the Contractor shall show that an ample quantity of material is available. Stone for riprap shall be of a suitable quality to ensure permanence in the structure and in the climate in which it is to be used. It shall be free from cracks, seams and other defects that would tend unduly to increase its deterioration from natural causes. The inclusion of objectionable quantities of dirt, sand, clay and rock fines will not be permitted.

2.2.2 Sources and Evaluation Testing

Riprap shall be obtained in accordance with the provisions of Special Contract Requirement 1.30 Stone Sources. The Contractor shall submit suitable test reports and service records to show the acceptability of the stone. If the Contractor proposes to furnish riprap from a source not currently listed, the Contractor shall make such investigations as necessary to determine whether acceptable stone can be produced from the proposed source. Satisfactory service records on work outside the Corps of Engineers will be acceptable. If no such records are available, the Contractor shall make tests to assure the acceptability of the stone. The tests to which the stone may be subjected will include petrographic analysis, specific gravity, abrasion, absorption, wetting and drying, freezing and thawing and such other tests as may be considered necessary by the Contracting Officer. The following guidance is provided for use by the Contractor in analyzing a new source of stone. Stone that weighs less than 150 lbs/c.f. and has more than 2% absorption will not be accepted unless other tests and service records show that the stone is

satisfactory. The method of tests for unit weight will be CRD-C 106, "Standard Test Method for Unit Weight and Voids in Aggregate". The method of tests for absorption will be CRD-C 107, entitled "Standard Test Method for Specific Gravity and Absorption of Coarse Aggregate". Samples shall be taken by the Contractor under the supervision of the Contracting Officer at least 60 days in advance of the time the placing of the stone is expected to begin. The tests will be conducted in accordance with applicable Corps of Engineers methods of tests given in the Handbook for Concrete and Cement, and will be performed at an approved testing laboratory. The cost of testing will be borne by the Contractor.

2.2.3 Gradation

Gradation shall conform to the following table and to Plates I and II at the end of this section and format thereof shall be as shown. Neither the width nor the thickness of any piece shall be less than one-third of its length. An allowance of 5 percent by weight for inclusion of quarry spalls will be permitted. Stone shall be reasonably well graded between the largest and smallest pieces. The table below describes the upper and lower limit curves for the riprap gradation. The graph of the riprap when plotted on ENG Form 4794-R with the limit curves plotted thereon is inserted at the end of this section as Plates I and II. The graph of the riprap must lie between these upper and lower limit curves.

TABLE I
(For Riprap R200)

<u>Percent Lighter by Weight (SSD)</u>	<u>Limits of Stone Weight, lb.</u>
100	200-80
50	80-40
15	40-10

(For Riprap R650)

100	650-260
50	280-130
15	130-40

2.2.4 Test Method

Gradation test method shall conform to the requirements of "LMVD Standard Test Method for Gradation of Riprap." Inserted at the end of this section are an Example Gradation and Worksheet (Plate III), an Example Gradation plotted on ENG Form 4794-R (Plate IV), and an example Gradation Test Data Sheet (Plate V).

2.2.5 Gradation Test

The Contractor shall perform a gradation test or tests on the riprap at the quarry. At least one gradation test shall be performed. The sample shall be taken by the Contractor under the supervision of the Contracting Officer, shall consist of not less than 15 tons of riprap and shall be collected in a random manner which will provide a sample which accurately reflects the actual gradation arriving at the jobsite. If collected by the truckload, each truckload shall be representative of the gradation requirements. The Contractor shall provide all necessary screens, scales and other equipment, and the operating personnel therefor, and shall grade the samples, all at no additional cost to the Government.

PART 3 EXECUTION

3.1 BASE PREPARATION

Areas on which the filter material and riprap are to be placed shall be dressed to conform to cross sections shown on the contract drawings and as specified in SECTION 02221 – EXCAVATION, FILL, BACKFILL AND EMBANKMENT FOR STRUCTURES. Humps and depressions within the slope lines shall be dressed to provide relatively smooth and uniform surfaces. Immediately prior to placing the filter material, the prepared base will be inspected by the Contracting Officer and no material shall be placed thereon until that area has been approved.

3.2 PLACEMENT OF FILTER MATERIAL

Filter material for riprap bedding shall be spread uniformly on the prepared base to the lines and grades as indicated on the contract drawings and in such manner as to avoid damage to the prepared base. Any damage to the surface of the prepared base during placing of the material shall be repaired before proceeding with the work. Compaction of material placed on the prepared base will not be required, but each layer shall be finished to present a reasonably even surface, free from mounds or windrows. The allowable deviation from the prescribed thickness shall be plus 2 inches.

3.3 RIPRAP

3.3.1 General

Riprap shall be placed on the prepared base and/or filter material within the limits shown on the contract drawings. Riprap shall be as specified in 2.2 above.

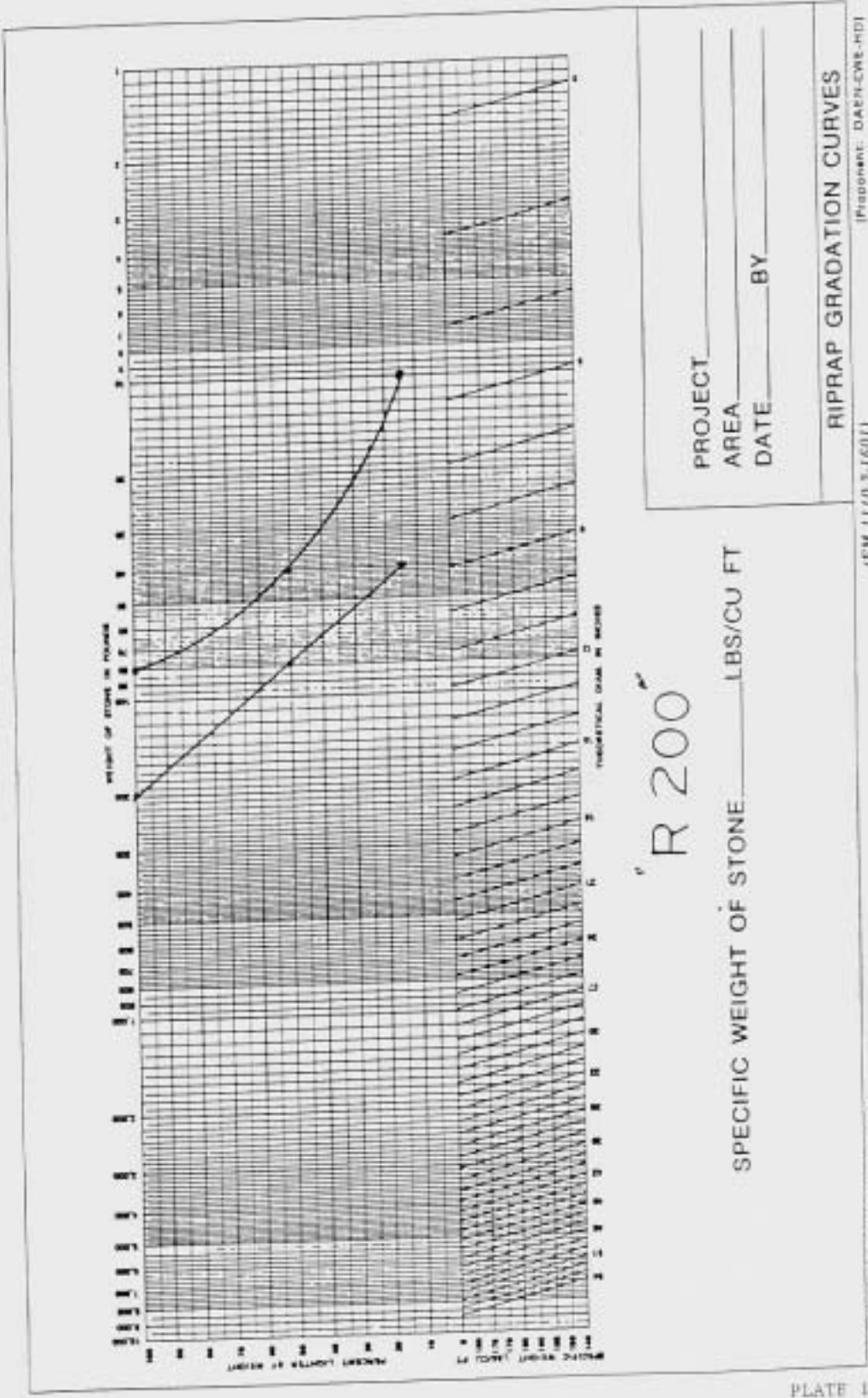
3.3.2 Placement

Riprap shall be placed in a manner which will produce a reasonably well-graded mass of rock with the minimum practicable percentage of voids, and shall be constructed, within the specified tolerance, to the lines and grades indicated on the contract drawings. A tolerance maximum of plus 2 inches from the slope lines and grades shown on the contract drawings will be allowed in the finished surface of the riprap, except that the extreme of this tolerance shall not be continuous over an area greater than 200 square feet. Riprap shall be placed to its full course thickness in one operation and in such manner as to avoid displacing the filter material. The larger stones shall be well distributed and the entire mass of stones in their final position shall be graded to conform to the gradation specified in 2.2.3. The finished riprap shall be free from objectionable pockets of small stones and clusters of larger stones. Placing riprap in layers will not be permitted. Placing riprap by dumping it into chutes, or by similar methods likely to cause segregation of the various sizes, will not be permitted. Placing riprap by dumping it at the top of the slope and pushing it down the slope will not be permitted. The desired distribution of the various sizes of stones throughout the mass shall be obtained by selective loading of the material at the quarry or other source; by controlled dumping of successive loads during final placing; or by other methods of placement which will produce the specified results. All dump trucks used for placing stone shall be equipped with bottom-hinged tailgates. The gate's releasing mechanism shall be arranged so that it may be operated only from location at or near the front of the truck. Each truckload shall be representative of the gradation requirements. Rearranging of individual stones by mechanical equipment or by hand will be required to the extent necessary to obtain a reasonably well-graded distribution of stone sizes as specified above.

3.3.3 Maintenance

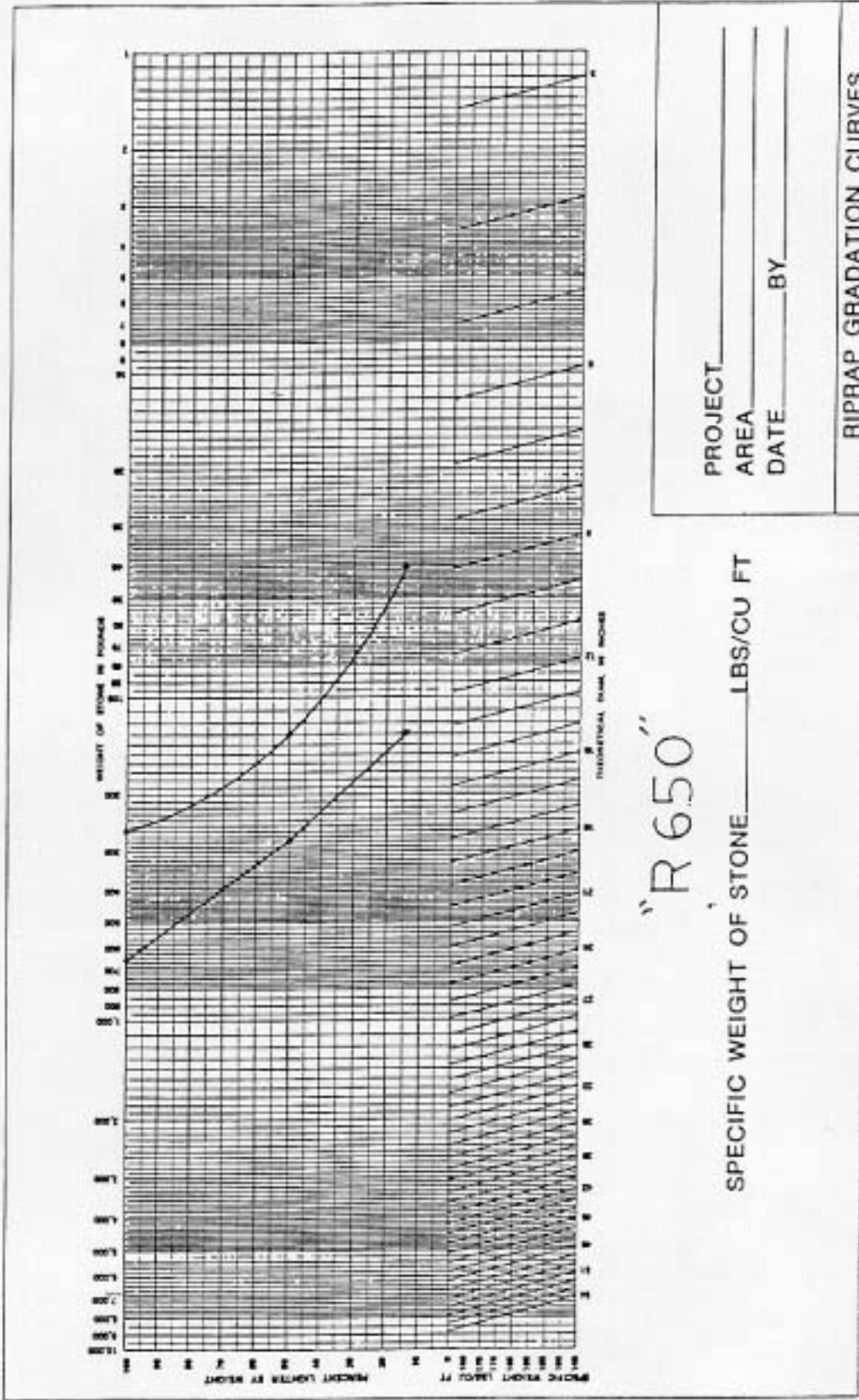
The Contractor shall maintain the riprap until accepted, and any material displaced prior to acceptance and due to the Contractor's negligence shall be replaced at his expense and to the lines and grades shown on the contract drawings.

End of Section



ENG FORM 4794 R, Sep 82

PLATE 1



FOR
EXAMPLE
ONLY

EXAMPLE GRADATION
SPECIFICATIONS

STONE WEIGHT IN LBS.	PERCENT FINER BY WEIGHT
400-160	100
160-80	50
80-30	15

EXAMPLE WORKSHEET

STONE SIZE LBS.	INDIVIDUAL WT. RETAINED	INDIVIDUAL PERCENT RETAINED	CUMULATIVE RETAINED	PERCENT PASSING
400	0	0	0	100
160	9,600	30	30	70
80	11,200	35	65	35
30	8,000	25	90	10
-30	3,200	10	100	-

TOTAL 32,000 lbs.

NOTE: Largest stone 251 lbs.

PLATE III

TEST RESULTS

GRADATION LIMITS

PROJECT LMD EXAMPLE GRADATION PLOT

AREA _____ EXAMPLE ONLY

DATE _____ BY _____

For Example

SPECIFIC WEIGHT OF STONE _____ LBS/CU FT

Only

ENG FORM 4794-R, Sep 82

(CM 1110 2-1601)

(Prepared: DAEN-CWE-HD)

PLATE IV

GRADATION TEST DATA SHEET

Quarry _____ Type of Stone Tested _____

Date of Test _____ Testing Rate _____

TEST	REPRESENTS
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9
10	10
11	11
12	12
13	13
14	14
15	15
16	16
17	17
18	18
19	19
20	20
21	21
22	22
23	23
24	24
25	25
26	26
27	27
28	28
29	29
30	30
31	31
32	32
33	33
34	34
35	35
36	36
37	37
38	38
39	39
40	40
41	41
42	42
43	43
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45	45
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47	47
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49	49
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67	67
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69	69
70	70
71	71
72	72
73	73
74	74
75	75
76	76
77	77
78	78
79	79
80	80
81	81
82	82
83	83
84	84
85	85
86	86
87	87
88	88
89	89
90	90
91	91
92	92
93	93
94	94
95	95
96	96
97	97
98	98
99	99
100	100

Contract No.

District

Tons

	TOTAL	

GRADATION

Stone Size
(lbs)

Weight Retained

Individual
% Retained

Cumulative	
% Ret.	% Pass

Specification
% Finer by wt

Total Weight					

Remarks: _____

I certify that the above stone sample is representative of the total tonnage covered by this test report.

Contractor Representative _____

Government Representative _____

LMV FORM 602-R

PLATE V

DIVISION 2 - SITE WORK

SECTION 02546

CLAY-GRAVEL SURFACE COURSE

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SECTION 02546

CLAY-GRAVEL SURFACE COURSE

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) PUBLICATIONS.

ASTM C 117	(1995) Materials Finer than 75-micrometer (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C 131	(1996) Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 136	(1996)a Sieve Analysis of Fine and Coarse Aggregates
ASTM D 75	(1997) Sampling Aggregates
ASTM D 422	63(1998) Particle-Size Analysis of Soils
ASTM D 1556	90(1996)e1 Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	91(1998) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft ³ . (2,700 kN-m/m ³))
ASTM D 3740	(1996) Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
ASTM D 4253	(1993) Maximum Index Density and Unit Weight of Soils Using a Vibratory Table
ASTM D 4318	(1998) Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM E 11	(1995) Wire Cloth and Sieves for Testing Purposes

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with the SECTION 01330 entitled SUBMITTAL PROCEDURES.

SD-01 Data.

Equipment: FIO.

A list of proposed equipment to be used in performance of construction work including descriptive data.

SD-09 Reports.

Sampling and Testing: GA.

Calibration curves and related test results prior to using the device or equipment being calibrated. Copies of field and laboratory test results within 24 hours after the tests are performed. Test results from samples, not less than 30 calendar days before material is required for the work. Results of laboratory tests for Quality Control purposes prior to using the material.

1.3 WEATHER LIMITATIONS

Compacted clay/gravel surface courses shall not be constructed when the ambient temperature is below 35 degrees F and on subgrades that are frozen or contain frost. It shall be the Contractor's responsibility to protect, by approved method or methods, areas of surfacing that have not been accepted by the Contracting Officer. Surfaces damaged by freeze, rainfall, or other weather conditions shall be brought to a satisfactory condition by the Contractor.

1.4 STOCKPILING MATERIALS

Prior to stockpiling material, the storage sites shall be cleared and leveled by the Contractor. Aggregates shall be so stockpiled as to prevent segregation. Aggregates and binders obtained from different sources shall be stockpiled separately.

PART 2 PRODUCTS

2.1 EQUIPMENT

Plant, equipment, and tools used in the performance of the work covered by this Section will be subject to approval by the Contracting Officer before the work is started and shall be maintained in satisfactory working condition at all times. The equipment shall be adequate and shall have the capability of producing the required compaction, and meeting the grade and thickness controls, and smoothness requirements set forth herein.

2.2 MATERIALS.

2.2.1 Aggregates

Aggregates shall consist of clean, sound, durable particles of natural gravel, crushed gravel, crushed stone, sand, slag, soil, or other approved materials processed and blended or naturally combined. Aggregates shall be free from lumps and balls of clay, organic matter, objectionable coatings, and other foreign materials. The Contractor shall be responsible for obtaining materials that meet the specification and can be used to meet the grade and smoothness requirements specified herein after compaction operations have been completed.

2.2.1.1 Coarse Aggregates

The material retained on the No. 4 sieve shall be known as coarse aggregates. Coarse aggregates shall be reasonably uniform in density and quality. Coarse aggregates shall have a percentage of wear not to exceed 50 percent after 500 revolutions as determined by ASTM C 131. The amount of flat or elongated particles shall not exceed 20 percent. A flat particle has a ratio of width to thickness greater than 3; an elongated particle has a ratio of length to width greater than 3. When the coarse aggregates are supplied from more than one (1) source, aggregates from each source shall meet the requirements set forth herein.

2.2.1.2 Fine Aggregates

The material passing the No. 4 sieve shall be known as fine aggregates. Fine aggregates shall consist of screenings, sand, soil, or other finely divided mineral matter that is processed or naturally combined with the coarse aggregates.

2.2.2 Gradation Requirements

Gradation requirements specified in TABLE I below, shall apply to the completed clay/gravel surface. It shall be the Contractor's responsibility to obtain materials that will meet the gradation requirements after mixing, placing, compacting, and other operations. TABLE I shows permissible gradings for granular material used in clay/gravel surfacing. Sieves shall conform to ASTM E 11.

TABLE I. GRADATION FOR CLAY-GRAVEL SURFACE COURSES

Sieve Designation	No. 1	No. 2
1 in.	100	100
3/8 in.	50-85	60-100
No. 4	35-65	50-85
No. 10	25-50	40-70
No. 40	15-30	24-45
No. 200	8-15	8-15

2.2.3 Liquid Limit and Plasticity Index

The portion of the completed clay/gravel aggregate surface course passing the No. 40 sieve shall have a maximum liquid limit of 35 and a plasticity index of 4 to 9.

2.3 DEGREE OF COMPACTION

Degree of compaction is a percentage of the maximum laboratory dry density obtained by the test procedure presented in ASTM D 1557 or ASTM D 4253. American Society for Testing and Materials ASTM D 1557 shall be used for soils containing 15 percent or more passing the number 200 sieve (fines). The maximum laboratory dry density for soils containing between 5 and 15 percent fines shall be determined by yielding the highest laboratory dry density. Degree of compaction shall be expressed as a percentage of the maximum laboratory dry density obtained by the appropriate procedure defined above.

2.4 SAMPLING AND TESTING

Sampling and testing shall be the responsibility of the Contractor. Sampling and testing shall be performed by an approved commercial testing laboratory or by the Contractor, subject to approval. If the Contractor elects to establish testing facilities, approval of the facilities shall be based on compliance with ASTM D 3740, and work requiring testing will not be permitted until the Contractor's facilities have been inspected and approved.

2.4.1 Sampling

Sampling for material gradation, liquid limit, and plastic limit tests shall be taken in conformance with ASTM D 75. When deemed necessary, the sampling will be observed by the Contracting Officer.

2.4.2 Testing

2.4.2.1 Gradation

Before starting work, at least one (1) sample of material shall be tested in conformance with ASTM C 117, ASTM C 136, and ASTM D 422. Sieves shall conform to ASTM E 11. After the initial test, a minimum of three (3) analyses shall be made for each day's run.

2.4.2.2 Liquid Limit and Plasticity Index

One (1) liquid limit and plasticity index shall be performed for each gradation test. Liquid limit and plasticity index shall be determined in accordance with ASTM D 4318.

2.4.2.3 Optimum Moisture and Maximum Laboratory Dry Density

The maximum laboratory dry density shall be determined from materials obtained from a field density test location using the appropriate method specified in the Paragraph: DEGREE OF COMPACTION, above. When ASTM D 1557 is used, the optimum moisture content shall be determined. A minimum of one (1) maximum laboratory dry density test shall be run each placement day or fraction thereof. Additional maximum laboratory dry density shall be run for each material change.

2.4.2.4 Wear Tests

Wear tests shall be performed in accordance with ASTM C 131. A minimum of one (1) test per aggregate source shall be run.

2.4.3 Approval of Materials

The source of the material to be used for producing aggregates shall be selected 30 calendar days prior to the time the material will be required in the work. Approval of sources not already approved by the U.S. Army Corps of Engineers will be based on an inspection by the Contracting Officer. Tentative approval of materials will be based on appropriate test results on the aggregate source. Final approval of the materials will be based on tests for gradation, liquid limit, and plasticity index performed on samples taken from the completed and compacted surface course.

PART 3 EXECUTION

3.1 OPERATION OF AGGREGATE SOURCES

The aggregate sources shall be operated to produce the quantity and quality of materials meeting these specification requirements in the specified time limit. Aggregate sources shall be conditioned in agreement with local laws or authorities.

3.2 MIXING AND PLACING MATERIALS

Materials shall be mixed and placed to obtain uniformity of the material and at a uniform optimum water content for compaction. The Contractor shall make adjustments in mixing or placing procedures or in equipment to obtain true grades, to minimize segregation and degradation, to obtain the desired water content, and to ensure a satisfactory surface course.

3.3 PREPARATION OF UNDERLYING EMBANKMENT

The underlying embankment shall be cleaned of foreign substances and during surface course construction, the underlying embankment shall contain no frozen material. Ruts or soft yielding spots in the underlying embankment having inadequate compaction and deviations of the surface from the requirements set forth herein shall be corrected by loosening and removing soft or unsatisfactory material and by adding approved material, reshaping to line and grade, and recompact to density requirements specified in the Section 02330 EMBANKMENT (FOR LEVEES). The completed underlying embankment shall not be disturbed by traffic or other operations and shall be maintained by the Contractor in a satisfactory condition until the surface course is placed.

3.4 GRADE CONTROL

During construction, the lines and grades indicated for the clay/gravel surface course shall be maintained.

3.5 LAYER THICKNESS

The clay/gravel material shall be placed in layers of uniform thickness. No layer shall exceed 6 inches nor be less than 3 inches when compacted.

3.6 COMPACTION

Each layer of the clay/gravel surface course shall be compacted with approved compaction equipment. The water content during the compaction procedure shall be maintained at optimum or at the percentage specified by the Contracting Officer. In locations not accessible to the rollers, the mixture

shall be compacted with mechanical tampers. Compaction shall continue until each layer through the full depth is compacted to at least 100 percent of maximum laboratory dry density. Materials that are found to be unsatisfactory shall be removed and replaced with satisfactory material or reworked to produce a satisfactory material.

3.7 EDGES OF AGGREGATE-SURFACED ROAD

Approved material shall be placed along the edges of the clay/gravel aggregate surface course in a quantity that will compact to the thickness of the course being constructed. When the course is being constructed in two (2) or more layers, at least 1-foot of shoulder width shall be rolled and compacted simultaneously with the rolling and compacting of each layer of the surface course.

3.8 SMOOTHNESS TEST

The surface of each layer shall not show deviations in excess of 3/8-inch when tested with a 10-foot straightedge applied both parallel with and at right angles to the centerline of the area to be surfaced. Deviations exceeding this amount shall be corrected by the Contractor by removing material, replacing with new material, or reworking existing material and compacting, as directed.

3.9 THICKNESS CONTROL

The completed thickness of the clay/gravel surface course shall be within plus 1/2-inch of the thickness indicated, and shall not be continuous over an area greater than 200 square feet. The thickness of the clay/gravel surface course shall be measured at intervals so that there will be a thickness measurement for at least each 500 square yards of the clay/gravel surface course. The thickness measurement shall be made by test holes at least 3 inches in diameter through the clay/gravel surface course. When the measured thickness of the clay/gravel surface course is more than 1/2-inch deficient in thickness, the Contractor, at no additional expense to the Government, shall correct the areas by scarifying, adding mixture of proper gradation, reblading, and recompacting as directed.

3.10 DENSITY TESTS

Density shall be measured in the field in accordance with ASTM D 1556. For the method presented in ASTM D 1556, the base plate shown shall be used. The gradation, liquid limit and plasticity index, optimum moisture content, and maximum laboratory dry density test specified in the Paragraph: Sampling above, shall be run on materials obtained from a field density test location. At least one (1) field density shall be performed for each 500 square yards of each layer of material placed.

3.11 MAINTENANCE

The clay/gravel surface course shall be maintained in a condition that will meet the specification requirements until accepted.

End of Section

DIVISION 2 - SITE WORK

SECTION 02547

AGGREGATE BASE COURSE

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End of Section Table of Contents

SECTION 02547

AGGREGATE BASE COURSE

PART 1 GENERAL

1.1 SCOPE

The work provided for in this section consists of furnishing all plant, labor, materials and equipment and performing all operations necessary for furnishing and placing aggregate on a prepared subgrade, all as indicated on the drawings and/or specified herein.

1.2 QUALITY CONTROL

The Contractor shall establish and maintain quality control for the work specified in this section to assure compliance with contract requirements and maintain records of his quality control for all construction operations including but not limited to the following:

(1) Subgrade Preparation

Grading, compaction.

(2) Base Course

Materials, placement, compaction.

A copy of these records and tests, as well as the records of corrective action taken, shall be furnished the Government.

1.3 APPLICABLE PUBLICATIONS

The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent indicated by the reference thereto:

MISSOURI STANDARD SPECIFICATIONS FOR HIGHWAY CONSTRUCTION, 1996 EDITION

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS
(AASHTO)

Standard Specifications for Highway Bridges, Fifteenth Edition, 1992

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Aggregate Base Course

The aggregate base course shall conform to the material specified in SECTION 1007.1, TYPE 1 AGGREGATE, of the Missouri Standard Specifications for Highway Construction. All aggregate material furnished under this contract shall comply favorably with approved representative samples as to quality, gradation and moisture content.

2.1.1.1 Sampling and Testing

2.1.1.1.1 General

Representative samples for testing of the material shall be taken by the Contractor under the supervision of the Contracting Officer. All costs of sampling and testing, except as specified in 2.1.1.1.3 below, shall be borne by the Contractor and no separate payment will be made therefor.

2.1.1.1.2 Contractor Testing

Prior to delivery of any material to job site, the material shall be tested for compliance with the specifications by an approved independent testing laboratory. Such tests shall be performed for each 5,000 cubic yards of material or increments thereof placed under this contract, and in the event a noticeable change in the materials is observed during placement, such testing shall be performed at the direction of the Contracting Officer regardless of the quantity of material delivered. Certified results of the tests shall be submitted to the Contracting Officer for approval.

2.1.1.1.3 Government Testing

At the same time that samples for Contractor testing as specified in 2.1.1.1.2 above are taken, the Contractor shall take samples for assurance testing to be performed by and at the expense of the Government. Assurance testing requires approximately 5 days. Notice of assurance sample deliveries shall be given to the Contracting Officer's representative prior to delivery.

2.1.2 Gradation

The aggregates shall conform to the following gradation requirements:

	Percent by Weight
Passing 1 inch sieve	100
Passing ½ inch sieve	60-90
Passing No. 4 sieve	40-60
Passing No. 40 sieve	15-35

The fraction passing the No. 40 sieve shall have a plasticity index not to exceed six.

2.2 EQUIPMENT

A self-propelled steel wheel roller weighing not less than 10 tons shall be used in preparing any subgrade for flexible type surfacing.

PART 3 EXECUTION

3.1 SUBGRADE

The subgrade shall be substantially uniform in density throughout its entire width. It shall conform to the lines, grades and typical cross sections shown in the plans, or as established by the Contracting Officer. Where hauling results in ruts or other objectionable irregularities, the Contractor shall reshape and reroll the subgrade before the base is placed.

All subgrades shall be rolled and compacted in accordance with Section 02330 EMBANKMENT FOR LEVEES, paragraph SEMICOMPACTED EMBANKMENT. The subgrades shall be checked after rolling and, if not at the proper elevation at all points, sufficient material shall be removed or added and compacted to bring all portions of the subgrade to the required elevation and density. The upper twelve (12) inches of the subgrade shall be compacted to 95% of maximum density.

3.2 PLACEMENT

3.2.1 Placement of Aggregate Base Course

The aggregate base course shall be placed upon the prepared surface as indicated on the drawings and shall be spread and shaped so as to produce a compacted finished base course conforming to the lines and grades as indicated on the contract drawings.

3.2.2 Mixing

Any additional material required and sufficient water to obtain the desired compaction shall be thoroughly mixed and delivered to the site as a combined product.

3.3 SHAPING AND COMPACTING

Immediately before spreading the mixture, the subgrade shall be sprinkled as directed by the Contracting Officer. The mixture shall be uniformly spread in a layer of such depth that when compacted, the base will have the approximate thickness specified.

Shaping and compacting shall be performed until a true, even and uniform surface of proper grade, cross section and density is obtained. Type 1 aggregate base shall be compacted to not less than standard maximum density. The Standard Compaction Test will be made in accordance with AASHTO T 99, Method C, replacing any material retained on the $\frac{3}{4}$ inch sieve. Field density will be determined in accordance with AASHTO T 191 or T 205, using the total material or AASHTO T 238, Method B Direct Transmission, for wet density. The volume of the test hole may be reduced as necessary to accommodate available testing equipment. If nuclear density test methods are used, moisture content will be determined in accordance with AASHTO T 239, except that a moisture correction factor will be determined for each aggregate in accordance with MoDOT Test Method T35.

Shaping of the completed surface of the aggregate base for flexible type surfacing shall be continued until the deviation from the required elevation does not exceed a roughly compensating maximum of $\frac{1}{2}$ inch.

The surface of the aggregate base shall be well drained at all times. If at any time the compacted aggregate base or subgrade becomes unstable, the Contractor, at the Contractor's expense, shall restore the subgrade and the aggregate base to the required grade, cross section and density.

3.4 MAINTENANCE

The Contractor shall maintain the required density and surface condition of any portion of the completed aggregate base until the prime coat or pavement is placed.

End of Section

DIVISION 2 - SITE WORK

SECTION 02548

ASPHALTIC CONCRETE SURFACING

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SECTION 02548

ASPHALTIC CONCRETE SURFACING

PART 1 GENERAL

1.1 SCOPE

The work provided for in this section consists of furnishing all plant, labor, materials and equipment and performing all operations necessary for priming the base course, and construction of the asphaltic concrete surfacing, all as indicated on the drawings and/or specified herein.

For the purpose of this specification, the terms “Asphaltic Concrete Surfacing” and “Plant Mix Bituminous Pavement” shall have the same meaning.

1.2 QUALITY CONTROL

The Contractor shall establish and maintain quality control for the work specified in this section to assure compliance with contract requirements and maintain records of his quality control for all construction operations including but not limited to the following:

- (1) Prime Coat

Materials, coverage.

- (2) Asphaltic Concrete Surfacing

Materials, temperature, width, thickness, compaction.

A copy of these records and tests, as well as the records of corrective action taken, shall be furnished the Government.

1.3 APPLICABLE PUBLICATIONS

The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent indicated by the reference thereto:

MISSOURI STANDARD SPECIFICATIONS FOR HIGHWAY CONSTRUCTION, 1996 EDITION

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS
(AASHTO)

Standard Specifications for Highway Bridges, Fifteenth Edition, 1992

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Asphaltic Material

All material shall conform to Division 1000, Materials Details of the Missouri Standard Specifications for Highway Construction, and specifically as follows:

Item	MoDOT
Asphalt Cement (AC-5, AC-10 or AC-20) 1015.5 Asphalt Cement, Performance Graded (PG)	1015.8
Coarse Aggregate	1002.1.1 to 1002.1.3, incl.
Fine Aggregate	1002.2.1
Mineral Filler	1002.3

The grade of asphalt cement will be specified in the job-mix formula.

The gradation of coarse aggregate shall be such that the total aggregate meets the mixture specified prior to being fed into the cold aggregate feeders.

2.1.2 Prime Coat

The prime coat shall be in accordance with Section 408 of the Missouri's Standard Specifications.

2.1.3 Composition of Aggregates

2.1.3.1 Gradation of Combined Aggregates

The total aggregate prior to mixing with asphalt cement, shall meet the following mixture.

Sieve Size	Percent Passing by Weight
¾ inch	100
½ inch	95-100
No. 4	60-90
No. 8	40-70
No. 30	15-35
No. 200	4-12

2.1.3.1.1 Gravel

If gravel, or if flint chat as produced in the Joplin area, is used, not less than 15% nor more than 30% crushed stone screenings, or dolomite chat screenings as produced in the Southeast Missouri Lead Belt Area, or not less than 4% mineral filler by weight shall be added as a separate ingredient. Screenings shall consist of tough durable particles of approved quality, shall be free from dirt or other objectionable material, and shall have 100 percent passing the 3/8 inch sieve.

2.1.3.1.2 Crushed Stone

If crushed stone, or if dolomite chat as produced in the Southeast Missouri Lead Belt Area, is used, not less than 15% nor more than 30% natural siliceous sand, porphyry sand or flint sand of approved quality shall be added as a separate ingredient. Wet bottom boiler slag of approved quality may be used as sand. Sand shall have 100% passing the 3/8 inch sieve and not more than 8% passing the No. 200 sieve.

2.1.3.1.3 Porphyry

If porphyry is used, sand as described in Section 2.1.3.1.2 or mineral filter may be added to meet gradation requirements.

2.1.3.1.4 Combinations

With written approval of the Contracting Officer, combinations of gravel, crushed stone, dolomite chat or porphyry, or combinations of flint chat, crushed stone, dolomite chat or porphyry, may be used. Not less than 15% nor more than 30% sand as specified in Section 2.1.3.1.2 shall be added as a separate ingredient. Each size and type of aggregate shall be added as a separate ingredient. Each size and type of aggregate shall be kept separate and fed through separate calibrated cold aggregate feeders to insure proper proportioning. No mixture will be approved which contains less than 30 percent of any one type of coarse aggregate in the combination. In addition, all plus No. 8 sieve fractions shall contain material from each type of coarse aggregate in the approved combination.

2.1.4 Composition of Mixtures

The composition of the mixture shall conform to the following limits by weight:

	Percent
Total Mineral Aggregate	92.0-96.5
Asphalt Cement	3.5-8.0

2.1.5 Testing

At least 30 days prior to preparing any of the mixture on the project, the Contractor shall obtain in the presence of the Contracting Officer representative samples of asphalt cement and mineral aggregates for tests. The samples of the material shall be of the size specified by the Contracting Officer and shall be submitted to the Laboratory for testing.

2.1.6 Job-Mix Formula

The Contractor shall also submit for the Contracting Officer's approval a job-mix formula for the mixture to be supplied for the project. No mixture will be accepted for use until the job-mix formula for the project is approved by the Contracting Officer. The job-mix formula shall be within the gradation range for the grade specified and shall include the type and sources of all material, the gradation of the aggregates, and the relative quantity of each ingredient and shall state a definite percentage for each fraction of aggregate. No job-mix formula will be approved which does not permit within the limits specified in SECTION 2.1.3.1 and 2.1.4 the full tolerances specified in SECTION 2.1.7 for asphalt cement and not less than ½ the tolerances designated for material passing the No. 8 sieve and the material passing the No. 200 sieve. The job-mix formula approved for the mixture shall be in effect until modified in writing by the Contracting Officer. When unsatisfactory results or other conditions make it necessary or

should a source of material be changed, a new job-mix formula may be required.

The Contracting Officer will make such changes in the proportions of asphalt cement and aggregates as he considers necessary. The proposed mixture will be compacted and tested in the Laboratory in accordance with AASHTO T 167 or AASHTO T 245 at the option of the Contracting Officer. The mixture of mineral aggregate and asphalt cement shall result in a bituminous mixture which will be durable and retain satisfactory cohesion in the presence of moisture. Chemical additions approved by the Contracting Officer may be made to the asphalt cement or to the mixture.

2.1.7 Gradation Control

In producing mixtures for the project, the plant shall be so operated that no intentional deviations from the job-mix formula are made. Mixtures as produced shall be subject to the following tolerances and controls:

- a. The total aggregate gradation shall be within the master range specified in SECTION 2.1.3.1 for the mixture specified.

- b. The maximum variation from the approved job-mix formula shall be within the following tolerances:

 Passing No. 8 sieve.....±5.0 percentage points
 Passing No. 200 sieve.....±2.0 percentage points

- c. The quantity of asphalt cement introduced into the mixer shall be that quantity specified in the job-mix formula. No change may be made in the quantity of asphalt cement specified in the job-mix formula without written approval of the Contracting Officer. The quantity of asphalt cement determined by calculations or tests on the final mixture shall not vary more than ±0.5 percentage points from the job-mix formula.

The gradation of the aggregate will be determined from samples taken from the hot bins on batch type or continuous mixing plants or from the composite cold feed belt on drum mix plants. Batch-type or continuous mixing plants shall have a screening unit which separates the usable heated aggregate into at least two sizes. One of the aggregate bin sizes produced by the screening unit shall contain not more than 10% by weight retained on the No. 4 sieve.

2.1.8 Commercial Mixture

If designated by the Contracting Officer that an approved commercial mixture may be used, the Contractor shall, at least seven days prior to the desired time of use, furnish a statement setting out the source and characteristics of the mixture the Contractor proposes to furnish. The statement shall include: (1) the types and sources of aggregates, percentage range of each and range of combined gradation; (2) the percent and grade of asphalt; and (3) the mixing time and range of mixture temperature. The plant shall be designed and operated to produce a uniform, thoroughly mixed material free from segregation. It will not be necessary for the plant to meet the requirements of 3.2 below. A field laboratory will not be required. If the proposed mixture and plant are approved by the Contracting Officer, the component material and the mixture delivered will be accepted or rejected by visual inspection. The supplier shall furnish with the first truck load of each day's production, a certification in triplicate that the material and mixture delivered are in conformance with the Contractor's approved proposal. Upon completion of the work, plant certification in triplicate shall be furnished by the supplier for the total quantity delivered. The mixture shall be transported and placed in accordance with the requirements specified in SECTION 3.4 through 3.8

below and shall be compacted as specified in SECTION 3.7.

PART 3 EXECUTION

3.1 WEATHER LIMITATIONS

Bituminous mixtures shall not be placed (1) when either the air temperature or the temperature of the surface on which the mixture is to be placed is below 50EF, (2) on any wet or frozen surface, (3) when weather conditions prevent the proper handling or finishing of the mixture, or (4) between October 1 and April 1 except when authorized by the Contracting Officer. Temperatures are to be obtained in accordance with MoDOT Test Method T20.

3.2 BITUMINOUS MIXING PLANTS

Bituminous mixing plants and preparation of material and mixtures shall conform to the requirements of SECTION 404 of the Missouri Standard Specifications.

3.3 BASE PREPARATION

The base upon which bituminous mixture is to be placed shall be prepared in accordance with SECTION 02547 and primed, as specified in accordance with SECTION 408 of the Missouri Standard Specifications.

3.4 HAULING EQUIPMENT

Trucks used for hauling bituminous mixtures shall comply with the requirements of SECTION 404 of the Missouri Standard Specifications.

3.5 SPREADING

The base course, primed surface or preceding course or layer shall be cleaned of all dirt, packed soil or any other foreign material prior to spreading the bituminous mixture. When placed on the roadbed, the mixture shall have a temperature of not less than 260EF. It shall be spread with an approved spreading and finishing machine in the number of layers and in the quantity required to obtain the compacted thickness and cross section shown on the plans. The paver shall be operated at a speed that will give the best results. The rate of delivery of the mixture to the paver shall be coordinated so as to provide, where practicable, a uniform rate of placement without intermittent operation of the paver. Automatic screed control shall be used on the finishing machine in accordance with SECTION 403.17 of the Missouri Standard Specifications. The compacted thickness of a single layer shall not exceed 2 inches for the surface course and 4 inches for the leveling course. On small areas, and on areas which are inaccessible to mechanical spreading and finishing equipment, the mixture may be spread and finished by hand methods when permitted by the Contracting Officer.

The mixture shall be spread without tearing the surface and struck off so that the surface is smooth and true to cross section, free from all irregularities and of uniform density throughout. Care shall be used in handling the mixture to avoid segregation. Areas of segregated mixture shall be removed and replaced with suitable mixture. The outside edges of the pavement shall be constructed to an angle of approximately 45 degrees with the surface of the roadbed. The outside edge alignment shall be uniform and any irregularities shall be corrected by adding or removing mixture before compacting.

3.6 JOINTS

Longitudinal and transverse joints shall be carefully made and well bonded. Transverse joints shall be formed by cutting back on the previous run so as to expose the full depth of the layer. When a transverse vertical edge is to be left and opened to traffic, a temporary depth transition shall be built as approved by the Contracting Officer. A single lane of any layer shall not be constructed to a length for which the adjacent lane cannot be completed the succeeding operating day. The longitudinal joints in one layer shall offset those in the layer immediately below by approximately 6 inches; however, the joints in the final layer shall be at the lane lines of the traveled way, except that the placement width shall be adjusted such that pavement marking shall not fall on a longitudinal joint.

3.7 COMPACTION

The mixture shall be thoroughly compacted by at least three complete coverages over the entire area with either a pneumatic tire roller or a tandem-type steel wheel roller each weighing not less than 10 tons. All rollers used shall be in satisfactory condition, capable of reversing without backlash, and steel wheel rollers shall be equipped with scrapers. Rollers shall have a system for moistening each roll or wheel. Rolling shall begin as soon after spreading the mixture as it will bear the weight of the roller without undue displacement. Final rolling shall be done by the steel wheel roller. Rolling shall be performed at proper time intervals and shall be continued until there is no visible evidence of further consolidation and until all roller marks are eliminated.

3.8 SURFACE TOLERANCES

The finished courses shall have the nominal thickness shown in the plans and shall be substantially free from waves or irregularities. The final riding surface shall not vary from a 10-foot straightedge, applied parallel to the centerline, by more than 1/8 inch. At transverse construction joints, the surface of all other layers shall not vary from the 10-foot straightedge by more than 1/4 inch. Surfaces exceeding these tolerances shall be re-rolled, replaced, or otherwise corrected in a manner satisfactory to the Contracting Officer.

The surface of the mixture after compaction shall be smooth and true to the established crown and grade. Any mixture showing an excess of asphalt cement or that becomes loose and broken, mixed with dirt, or is in any way defective shall be removed and replaced with satisfactory mixture, which shall be immediately compacted to conform with the surrounding area.

3.9 TESTING PAVEMENT

During construction, the Contracting Officer will make as many tests as are necessary to insure that the course is being constructed of proper thickness and composition. The Contractor will be required to cut samples of the compacted mixture from any course at locations designated by the Contracting Officer and shall deliver them to the laboratory in good condition. Samples may be obtained by either sawing with a power saw or by drilling 4-inch diameter cores. Each sawed sample shall consist of a single piece of the pavement of the size designated by the Contracting Officer but not larger than 12 inches square. Each cored sample shall consist of four cores. All samples shall be taken the full depth of the layer to be tested and shall consist of an undisturbed portion of the compacted mixture. The surface from which samples have been taken shall be restored by the Contractor not later than the next day of plant operation.

After construction is complete, the Contracting Officer will require samples to insure that the total thickness of the completed pavement is acceptable. The Contractor shall obtain samples for total

compacted thickness of all layers, including any bituminous base or leveling courses, at locations designated by the Contracting Officer. Each sample shall consist of one 4-inch diameter core taken the full depth of bituminous construction. The surface from which samples have been taken shall be restored by the Contractor within 48 hours using an approved commercial or “cold patch” mixture acceptable to the Contracting Officer.

End of Section

DIVISION 2 - SITE WORK

SECTION 02621

FOUNDATION DRAINAGE SYSTEM

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SECTION 02621

FOUNDATION DRAINAGE SYSTEM

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 74	(1998) Cast Iron Soil Pipe and Fittings
ASTM C 497	(1998) Concrete Pipe, Manhole Sections, or Tile
ASTM C 14	(1995) Concrete Sewer, Storm Drain, and Culvert Pipe
ASTM D 3034	(1998) Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM F 480	(1995) Thermoplastic Well Casing Pipe and Couplings Made in Standard Dimension Ratios (SDR), SCH 40 and SCH 80
ASTM F 758	(1995) Smooth-Wall Poly (Vinyl Chloride) (PVC) Plastic Underdrain Systems for Highway, Airport, and Similar Drainage
ASTM F 949	(1996)a Poly (Vinyl Chloride) (PVC) Corrugated Sewer Pipe With a Smooth Interior and Fittings

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-13 Certificates

Materials; FIO.

Certifications from the manufacturers attesting that materials meet specification requirements.

SD-14 Sample

Materials; FIO.

Two randomly selected samples of each type of pipe and fitting, prior to delivery of materials to the site.

1.3 DELIVERY, STORAGE AND HANDLING

Materials placed in storage shall be stored with protection from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Plastic pipe shall not be exposed to direct sunlight for more than 6 months from time of manufacture to installation.

PART 2 PRODUCTS

2.1 MATERIALS

Pipe for foundation drainage system shall be of the type and size indicated. Appropriate transitions, adapters, or joint details shall be used where pipes of different types or materials are connected.

2.2 Cylinder Concrete Pressure Pipe

ASTM C 497

2.2.1 Cast-Iron Soil Pipe

ASTM A 74, service

2.2.2 Polyvinyl Chloride (PVC) Pipe

ASTM F 758, Type PS 46, ASTM D 3034, or ASTM F 949 Schedule 40 Pipe

2.2.2.1 Circular Perforations in Plastic Pipe

Circular holes shall be cleanly cut with 3/8 inch in diameter, and arranged in rows parallel to the longitudinal axis of the pipe. Perforations shall be approximately 3 inches apart, center-to-center, along rows. The spigot or tongue end of the pipe shall not be perforated for a length equal to the depth of the socket and perforations shall continue at uniform spacing over the entire length of the pipe. Manufacturer's standard perforated pipe which essentially meets these requirements may be used with prior approval of the Contracting Officer.

2.2.3 Fittings

Fittings shall be of compatible materials for pipe, of corresponding weight and quality, and as specified herein.

2.2.4 Cleanouts and Piping Through Walls

Cleanout pipe and fittings and piping through walls and footings shall be cast-iron soil pipe. Each cleanout shall have a brass ferrule and a cast-brass screw-jointed plug with socket or raised head for wrench.

2.2.5 Piezometers

Piezometers shall be installed as shown on the plans. Piezometer pipe shall be new 1¼ inch schedule 40 flush-joint threaded PVC pipe. This shall be ASTM F 480 flush thread male by female fittings. A vented cap that threads or slips onto the top of the piezometer shall also be used.

2.2.6 Pervious Backfill for Foundation Drains

Bedding and pervious backfill shall be in accordance with Section 02221 EXCAVATION, FILL, BACKFILL AND EMBANKMENT FOR STRUCTURES.

2.2.7 Protective Covering for Pervious Backfill

Protective covering shall be filter fabric as specified in Section 02215, GEOTEXTILES USED AS FILTERS.

2.2.8 Filter Gravel for Foundation Drains

Filter gravel shall consist of gravel or crushed stone composed of tough, durable particles, reasonably free from thin, flat and elongated pieces, and shall contain no organic matter nor soft, friable particles in quantities considered objectionable by the Contracting Officer.

The filter gravel shall be well-graded between the limits shown. At least one test shall be performed on each 1,000 tons to be delivered to the project site for each specified gradation. All points on individual grading curves obtained from representative samples of filter stone shall lie between the boundary limits as defined by smooth curves drawn through the tabulated gradation limits plotted on ENG Form 2087 or similar form. The individual gradation curves within these limits shall not exhibit abrupt changes in slope denoting either skip grading or scalping of certain sizes or other irregularities which would be detrimental to the proper functioning of the filter.

Grading shall conform to the following requirements.

FILTER GRAVEL

U.S. Standard Sieve Size	Permissible Limits Percent by Weight, Passing
3 inches	100
1 ½ inches	85-100
¾ inch	35-70
3/8 inch	0-10
No. 4	0-2

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

3.1.1 Extent

Foundation drainage shall be furnished and installed as a complete system as shown on the plans.

3.1.2 Drainage Lines

Drainage lines shall be constructed of perforated pipe.

3.1.3 Outlet Lines

Outlet lines shall be constructed of closed-joint nonperforated, nonporous pipe.

3.2 INSTALLATION

3.2.1 Trenching and Excavation

Required trenching and excavation shall be in accordance with Section 02221 EXCAVATION, FILL, BACKFILL AND EMBANKMENT FOR STRUCTURES. Trenches shall be kept dry during installation of drainage system. Changes in direction of drain lines shall be made with 1/8 bends. Wye fittings shall be used at intersections.

3.2.2 Bedding

Graded bedding, minimum 6 inches in depth, shall be placed in the bottom of trench for its full width and length and compacted as specified prior to laying of foundation drain pipe. Each section shall rest firmly upon the bedding, through the entire length, with recesses formed for bell joints. Except for recesses for bell joints, the bedding shall fully support the lower quadrant of the pipe.

3.2.3 Pipe Laying

Drain lines shall be laid to true grades and alignment with a continuous fall in the direction of flow. Bells of pipe sections shall face upgrade. Interior of pipe shall be cleaned thoroughly before being laid. When drain lines are left open for connection to discharge lines, the open ends shall be temporarily closed and the location marked with wooden stakes. Perforated pipe shall be laid with perforations facing down. Any length that has had its grade or joints disturbed shall be removed and relaid at no additional cost to the Government. Perforated corrugated polyethylene drainage tubing and plastic piping shall be installed in accordance with manufacturer's specifications and as specified herein. Tubing and piping with physical imperfections shall not be installed.

3.2.4 Jointing

3.2.4.1 PVC and Perforated Pipes

PVC and perforated types of drain pipes shall be laid with closed joints.

3.2.4.2 Joints of Concrete Pipe

Joints of concrete pipe shall be caulked with oakum and filled solid with cement mortar except where compression joints conforming to ASTM C 425 are used on vitrified clay pipe.

3.2.4.3 Joints of Cast-Iron Pipe

Joints of cast-iron pipe or connections between cast-iron and porous concrete pipes shall be caulked with oakum gasket and filled with lead.

3.2.5 Outlet Lines

The outlet end of drain lines connecting with an open gutter or outfall shall be finished as shown.

3.2.6 Backfilling

After joints and connections have been inspected and approved, the specified pervious backfill material shall be placed for the full width of the trench and full width between pipe and adjacent walls and 12 inches above the top of the pipe. The backfill shall be placed preventing displacement of or injury to the pipe or tile. A protective covering, as specified, shall be placed over the pervious backfill for the full width of the trench before regular backfill is placed. Backfill shall be compacted as specified in Section 02221 EXCAVATION, FILL, BACKFILL AND EMBANKMENT FOR STRUCTURES.

3.2.7 Cleanouts

Cleanouts shall be provided in locations indicated. Cleanouts in unpaved areas shall be set as shown on the plans.

End of Section

DIVISION 2 - SITE WORK

SECTION 02670

WATER WELLS

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SECTION 02670

WATER WELLS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 53	(1993a) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM C 150	(1995) Portland Cement
ASTM D 2239	(1993) Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter
ASTM F 480	(1994) Thermoplastic Well Casing Pipe and Couplings Made in Standard Dimension Ratios (SDR), SCH 40 AND SCH 80

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA-10062JU	(1992) Standard Methods for the Examination of Water and Wastewater
AWWA A100	(1990) Water Wells
AWWA B300	(1992) Hypochlorites
AWWA B301	(1992) Liquid Chlorine
AWWA C200	(1991) Steel Water Pipe - 6 In. (150 mm) and Larger
AWWA C206	(1991) Field Welding of Steel Water Pipe

CODE OF FEDERAL REGULATIONS (CFR)

40 CFR 141	National Primary Drinking Water Regulations
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1.2 GENERAL REQUIREMENTS

The well shall be located as shown. The well shall be to such depth as may be necessary to penetrate a desirable water-bearing stratum and produce a continuous yield of 15 gpm of potable water. "Potable"

is defined to mean water that is suitable for public consumption, i.e., water free from objectionable amounts of harmful bacteria, chemical, and physical substances as established by 40 CFR 141.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-08 Statements

Work Plan; GA.

Proposed plan for drilling test holes and constructing production wells, before beginning work. The plan shall include, but not be limited to, the proposed method of drilling and equipment to be used, details on proposed casing, well screen, grouting materials and methods and equipment proposed for developing the well and for performing pump tests. No work shall be performed until the drilling plan has been approved and no deviation from the approved drilling plan will be permitted without approval of the Contracting Officer. Details of specific methods to be employed to control potential contamination or pollution arising from well installation activities, shall also be included.

SD-09 Reports

Tests; FIO.

Reports shall be made within 24 hours following the conclusion of each test.

SD-18 Records

Permits; FIO.

A copy of all permits, licenses, or other requirements necessary for execution of the work. Before beginning work, the local United States Geological Survey office shall be notified of the type and location of wells to be constructed, the method of construction and anticipated schedule for construction of the wells. A copy of all such correspondence shall be furnished.

Boring Log; FIO.

During the drilling of the test hole an accurate log shall be maintained. As a minimum, the log shall include depths, elevations, and descriptions of all formations encountered; identification of each stratum according to the Unified Soil Classification System; or standard rock nomenclature, as necessary; and depths at which groundwater is encountered. Soil samples shall be taken each 10 feet with a split-spoon sampler. Rock samples shall be taken each 10 feet using standard core drilling methods. The Contractor shall prepare a graphic boring log to scale showing the required details. Five prints of the boring log drawing shall be submitted. This drawing shall be used for determining the well design, design of the gravel filter, well screen location and screen openings.

1.4 ENVIRONMENTAL PROTECTION

The Contractor shall take all precautions as may be required to prevent contaminated water or water having undesirable physical or chemical characteristics from entering the water supply stratum through

the well bore or by seepage from the ground surface. The Contractor also shall take all precautions necessary to prevent contamination of the ground surface or of surface waters resulting from drilling of the test-hole or well.

1.5 ABANDONMENT OF WELLS

In the event that the Contractor fails to construct a well of the required capacity, or should the well be abandoned because of loss of tools or for any other cause, the Contractor shall fill the abandoned hole with sand-cement grout and remove the casing.

PART 2 PRODUCTS

2.1 CASING

The casing shall be of sufficient size for the maximum yield as specified. All casing, screen, and other well materials shall be of compatible materials to prevent galvanic reaction between components of the completed well.

2.1.1 Steel Casing and Couplings

Steel casing shall be standard weight galvanized steel pipe, conforming to ASTM A 53. Joints shall be either threaded and coupled, or field welded in accordance with AWWA C206. Casings shall be provided with drive shoes.

2.1.2 Plastic Casing and Couplings

Plastic casing pipe and couplings shall conform to ASTM F 480.

2.1.3 Inner Casing

The inner casing shall be sized based on the pump required in paragraph PERMANENT PUMP for maximum required yield, and shall be constructed of the same materials as the outer casing and the well screen. The inner casing shall be connected directly to the top of the well screen by an approved method.

2.2 WELL SCREENS

Well Screens shall be a minimum of 4 inches nominal diameter, and shall be directly connected to the bottom of the inner casing by an approved method. The screen shall be of sufficient length and shall provide an intake area capable of passing not less than the minimum required yield of the well at an entrance velocity not exceeding 0.1 fps. The opening size shall be compatible with the material surrounding the screen and shall be submitted for approval as part of the drilling plan. The well screen shall be of sufficient size and design to hold back and support the gravel used in the gravel envelope and in-situ material surrounding the screen. The screen and all accessories required for satisfactory operation shall be essentially standard products of reliable manufacturers regularly engaged in the production of such equipment. Field constructed screen is not acceptable. "Blanks" in the well screen may be utilized in nonproductive zones and shall be considered "casing."

2.2.1 Metal Screen

Metal screen shall be of an approved wire-wound type with wire not less than No. 7 AWG and the supporting bars not less than 1/4-inch thickness. Both wire and supporting bars shall be type 304 or type 316 stainless steel, conforming to the applicable requirements of AWWA A100. If a pipe core is used, it shall be at least schedule 10 pipe and shall be of the same material as the wire. A wire-wound screen manufactured with supporting bars or core of material different from the wire will not be acceptable. Joints shall be made of threaded couplings of the same material as the screens or by brazing or welding in accordance with AWWA C206.

2.2.2 Combination Screen

Well screens that are fabricated from two or more different materials may be substituted with prior approval. Approval will be based in part on past history of successful performance.

2.3 GRAVEL PACK

Gravel pack shall be a product of a commercial sand and gravel manufacturer, shall be properly sized and graded for the surrounding soil and water encountered, and shall be composed of round, hard, waterworn siliceous gravel, free of flat or elongated pieces, organic matter, or other foreign matter. The gravel shall be of such size as will allow the maximum flow of water into the well and prevent the infiltration of sand and silt. The gradation of the filter gravel shall be such that the uniformity coefficient is not more than 2.5.

2.4 CEMENT GROUT

Cement grout shall consist of portland cement conforming to ASTM C 150, Type I or II, sand and water. Cement grout shall be proportioned not to exceed 6 gallons of water per cubic foot of cement, with a mixture of such consistency that the well can be properly grouted. Not more than 3 percent by weight of bentonite powder may be added to reduce shrinkage.

2.5 PERMANENT PUMP

Permanent pump shall be an approved submersible type with a capacity sufficient to deliver 15 gpm at 125 psi. The bearings shall be oil lubricated and the shaft shall be stainless steel. The pump shall be connected to the pump controls by a three-wire drop line. Piping for the well drop line shall be polyethylene plastic pipe conforming to ASTM D 2239. The pump shall operate on 460 volts, 60 Hz, 3 phase power, and the motor shall be of sufficient size to operate the pump under the maximum operating conditions without exceeding its rating. Pump shall be equipped with all necessary controls to provide for automatic operation of the pump. The pump and motor unit shall be no larger than 4 inches in diameter at any point.

PART 3 EXECUTION

3.1 WELL CONSTRUCTION

3.1.1 General Requirements

The method of drill shall be as approved by the Contracting Officer and shall conform to all state and local standards for water well construction. The execution of the work shall be by competent workmen and performed under the direct supervision of an experienced well driller. Casing pipe, well screens,

and joint couplings shall be of compatible materials throughout each well. The well shall be a gravel pack well developed in the water-bearing stratum. The well shall be drilled straight, plumb, and circular from top to bottom. The well shall be initially drilled from the ground surface to the uppermost level of the water bearing strata and the bottom of the outer casing set at this elevation. The hole below the outer casing shall fully penetrate the water bearing stratum a sufficient depth to produce the required amount of water without causing excessive velocities through the aquifer.

3.1.2 Setting Outer Casing

The outer casing shall not be less than 8 inches in diameter. The hole shall be of sufficient size to leave a concentric annular space of not less than 2-1/2 inches between the outside of the outer casing and the walls of the hole. The annular space between the outer casing and the walls of the holes shall be filled with cement grout. Acceptable methods of grouting are detailed in AWWA A100. No method will be approved that does not specify the forcing of grout from the bottom of the space to be grouted towards the surface. A suitable grout retainer, packer, or plug shall be provided at the bottom of the inner casing so that grout will not leak into the bottom of the well. Grouting shall be done continuously in such a manner as will ensure that the entire annular space is filled in one operation. After grouting is completed, drilling operations shall not be resumed for at least 72 hours to allow proper setting of the grout.

3.1.3 Construction of Inner Casing and Screen

After the grout has set, the hole below the outer casing shall be underreamed at the required diameter to the required depth by an approved method which will prevent caving of the hole before or during installation of the gravel pack, well screen and inner casing. In lieu of underreaming, the entire well may be drilled to the diameter of the gravel pack with an annular space between the inner casing and outer casing equal to the thickness of the gravel pack. The outer casing shall be increased in size to provide for this space, if this option is elected. The well screen and inner casing shall be lowered into the hole by a method which will allow for control of the rate of fall of the well screen and inner casing at all times. Well screen and inner casing shall not be dropped or allowed to fall uncontrolled into the hole. The inner casing shall extend up through the outer casing to the ground surface. Approved centering devices shall be installed at a spacing of 120 degrees between the outer casing and inner casing prior to well construction at the top of the inner casing and the bottom of the outer casing.

3.1.4 Construction of Gravel Pack

After the screen and inner casing have been concentrically set in the hole below the outer casing, the approved gravel pack shall be constructed around the screen by filling the entire space between the screen and the wall of the hole in the water bearing stratum with filter gravel. Well screen and inner casing used for gravel pack wells shall have approved centering devices spaced 120 degrees apart at intervals not exceeding 25 feet along the length of the screen and inner casing. Gravel conductor pipe having an inside nominal diameter of not less than 1-1/2 inches shall be lowered to the bottom of the well between the hole and screen. Gravel conductor pipe shall be arranged and connected at the surface of the ground to water pumping and graving equipment so that water and gravel fed at uniform rates are discharged as the gravel fills the hole from the bottom up. The gravel and water conductor shall be raised at a rate that will keep the bottom of the pipe between 1 and 3 feet under the gravel level at all times. If the Contractor desires to use methods of placing gravel other than those specified, he shall submit to the Contracting Officer, for approval, details of the method and equipment proposed, before gravel placing is begun; however, dumping filter gravel from the surface of the ground and agitating the well in an effort to settle the filter will not be allowed. The gravel pack shall

be installed continuously and without interruption until the gravel has been placed to within 1 foot of the top of the inner casing.

3.1.5 Placing Packer

After the inner casing and well screen and gravel pack have been installed, the annular space between the inner and outer casings shall be sealed by use of an approved packer.

3.2 WELL DEVELOPMENT

After construction, the well shall be developed in accordance with the drilling plan. The Contractor shall develop the well by such methods as approved until the water pumped from the well is substantially free from sand and until the turbidity is less than 5 on the Jackson Turbidity Scale specified in AWWA-10062JU. Developing equipment shall be of an approved type and of sufficient capacity to remove all cutting fluids, sand, rock cuttings, and any other foreign material. The well shall be thoroughly cleaned from top to bottom before beginning the well tests.

3.3 TESTS

During construction of the well, whenever sufficient water is found to indicate that a well of required capacity may be developed, or when directed, a capacity test shall be performed. If the capacity test indicates that the required capacity can be obtained, the tests for quality of water shall be made. If the capacity and quality tests indicate that the required capacity and quality can be obtained, the permanent well, as specified, shall be completed at that depth. Prior to making quality tests, drilling equipment, tools and pumps contacting well water shall be cleaned with live steam.

3.3.1 Capacity Test

The Contractor shall furnish and install an approved temporary test pump, with discharge piping of sufficient size and length to conduct the water being pumped to point of discharge, and equipment necessary for measuring the rate of flow and water level in the well. A continuous 8 hour capacity test shall be run with the pumping rate and drawdown at the pump well and observation wells recorded every 30 minutes. The test shall begin at the rate of the expected capacity of well and at least that rate maintained throughout the duration of the test. If this capacity cannot be maintained for the test period, the capacity test shall be terminated and the test hole drilled deeper or relocated as directed. The record of the test, in triplicate, shall be delivered to the Contracting Officer.

3.3.2 Test for Plumbness and Alignment

Upon completion of the permanent well, plumbness and alignment shall be tested by lowering into the well, to the total depth of the well, a plumb 40 feet long or a dummy of the same length. The outer diameter of the plumb shall not be more than 1/2 inch smaller than the diameter of that part of the hole being tested. If a dummy is used, it shall consist of a rigid spindle with three rings, each ring being 12 inches wide. The rings shall be cylindrical and shall be spaced one at each end of the dummy and one in the center thereof. The central member of the dummy shall be rigid so that it will maintain the alignment of the axis of the rings. Should the plumb or dummy fail to move freely throughout the length of the casing or well screen for the depth of well or should the well vary from the vertical in excess of two-thirds the inside diameter of that part of the well being tested for each 100 feet of depth, the plumbness and alignment of the well shall be corrected by the Contractor. Should the faulty alignment and plumbness not be correctable, as determined by the Contracting Officer, the well shall

be abandoned as specified in paragraph ABANDONMENT OF WELLS and a new well drilled at no additional cost to the Government.

3.3.3 Test for Quality of Water

When the capacity test in the test hole has been completed, and again after the yield in the permanent well and drawdown test or capacity test have been completed, the Contractor shall secure samples of the water in suitable containers, and of sufficient quantity, to have bacterial, physical, and chemical analyses made by a recognized testing laboratory, except that the bacterial analysis may be made by the applicable State Board of Health, if desired. Water Quality Analysis shall address each item specified in the Water Quality Analysis Table at the end of this section. Expenses incident to these analyses shall be borne by the Contractor and the results of the analyses shall be furnished the Contracting Officer. All sampling and analyses shall be performed using EPA and State approved methods, procedures, and holding times.

3.4 INSTALLATION OF PERMANENT PUMP

The permanent well pump shall be installed in the well at a minimum depth of 25 feet below the maximum drawdown groundwater level after the drawdown test has been completed. The pump shall be secured at the required elevation as recommended by the pump manufacturer.

3.5 DISINFECTING

After completion of tests of well, or installation of permanent pump, or at time of tests for yield and drawdown test, whichever is later, the wells shall be disinfected by adding chlorine, conforming to AWWA B301, or hypochlorite, conforming to AWWA B300, in sufficient quantity that a concentration of at least 50 ppm of chlorine shall be obtained in all parts of the well. Chlorine solution shall be prepared and introduced into the well in an approved manner and shall remain in the well for period of at least 4 hours. Disinfection of well shall be in accordance with any method described in Sections A1 thru A10 of AWWA A100. After the contact period, the well shall be pumped until the residual chlorine content is not greater than 1.0 ppm. The well shall be disinfected and redisinfecting as may be required until two consecutive samples of water are found upon test to be free from Coli Acrogenes group of organisms.

3.6 WELL COVER AND SLAB

Well cover and slab shall be constructed so as to prohibit the infiltration of surface water or precipitation into the well. The slab shall be at 2 feet square by six inches thick and constructed of reinforced concrete. The top of the outer casing shall extend 12 inches above the top of the slab.

3.7 CLEAN-UP

Upon completion of the well construction and other incidentals, all debris and surplus materials resulting from the work shall be removed from the jobsite.

WATER QUALITY ANALYSIS TABLE

Characteristics

Physical

Color	Resistivity in ohms per cubic
Taste	centimeter and 25 degrees C.
Threshold odor number	pH value
Turbidity	Temperature

Chemical (Expressed as mg/l)

Arsenic	Total Hardness as CaCO(3)
Barium	Endrin
Cadmium	Lindane
Chromium	Methoxychlor
Copper	Toxaphene
Lead	2-4-D
Mercury	2, 4, 5 TP Silvex
Selenium	Total Organic Halogens
Silver	TOC
Zinc	
Fluoride as F	
Manganese as Mn (dissolved and total)	
Iron as Fe (dissolved and total)	
Suspended Solids	
Total Dissolved Solids	
Calcium as Ca	
Magnesium as Mg	
Sodium and Potassium as Na	
Sulphates as SO(4)	
Chlorides as Cl	
Bicarbonates as HCO(3)	
Carbonates as CO(3)	
Nitrates as NO(3)	
Alkalinity (methyl-orange)	
(Phenolphthalein) as CaCO(3)	
Silica as SiO(2)	

End of Section

DIVISION 2 - SITE WORK

SECTION 02707

LINED CYLINDER CONCRETE PRESSURE PIPE

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SECTION 02707

LINED CYLINDER CONCRETE PRESSURE PIPE

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 497 (1998) Concrete Pipe, Manhole Sections, or Tile

ASTM C 1107 (1997) Packaged Dry, Hydraulic-Cement Grout (Nonshrink)

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C301 (1992) Prestressed Concrete Pressure Pipe, Steel-Cylinder Type, for Water and Other Liquids

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Materials; GA.

Where materials are standard stock products of manufacturers, full descriptive data shall be submitted, including catalog cuts and specifications.

SD-04 Drawing

Shop Drawings; GA.

Before starting installation of any materials, the Contractor shall prepare and submit complete shop drawings of all work covered by this section, including installation details for the pipe, gaskets, joints and similar items requiring fabrication. These shop drawings shall include as a minimum the following drawings and catalog cuts:

- a. Lined cylinder concrete pressure pipe and fittings.
- b. Layout of pipe and all pipe lengths used.

SD-09 Reports

Pressure Testing; GA.

The Contractor shall submit test results.

SD-13 Certificates

Lined Cylinder Concrete Pressure Pipe; FIO.

The Contractor shall submit the pipe manufacturer's certified statement of the design strength of the pipe, consisting of:

- a. Design curve and Specifications Sheet:
 - (1) A copy of the appropriate design curve marked to show the resultant concrete core stress and corresponding three-edge bearing load of the pipe furnished; and
 - (2) A specification sheet for the pipe furnished showing all data and dimensions needed to compute the resultant concrete core stress; or
- b. Results of external crushing strength tests on pipe or pipe specimens (at least 2 feet in length) of equivalent size and design and composed of equivalent materials.
 - (1) The pipe manufacturer's certified statement of results of the hydrostatic tests required by the reference specification appropriate to the type of pipe furnished.
 - (2) The pipe manufacturer's certified statement of current typical test reports on steel and steel wire reinforcing and compression tests of the concrete used in the manufacture of the pipe.
 - (3) Such drawings and descriptions of the pipe joints as may be necessary to show that the joint conforms to the specified requirements.

1.3 DELIVERY AND STORAGE

All pipe sections and special fittings shall be marked by the manufacturer with the manufacturer's name or trademark, the date of manufacture, the nominal size, design head, design external load and the structure site for which it was designed and manufactured. All materials delivered and stored shall be handled and stored in such a manner that pipe, fittings and accessories are not damaged.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Lined Cylinder Concrete Pressure Pipe

The pipe shall be the diameters shown on the drawings and shall conform to the requirements of AWWA C301.

2.1.2 Joint Lubricant

Joint lubrication shall be as recommended by the pipe manufacturer.

2.1.3 Steel Reinforcement

The steel reinforcement shall conform to the requirements of AWWA C301 for the specified type of pipe, except that elliptical reinforcing cages or other reinforcements that require special orientation of the pipe during placement will not be allowed.

2.1.4 Joints

2.1.4.1 General

The pipe joints shall conform to the requirements of the applicable specifications for the pipe. They shall be bell-and-spigot type and shall have a positive groove in the spigot to contain the rubber gasket. The size and shape of the groove shall be such that it will prevent displacement of the gasket by either internal or external water pressure when the joint is in any position within the required range of movement capability. Joint sleeves, also referred to as “collars” or “coupling bands,” shall conform to the requirements for bell rings in the applicable pipe specifications. The joint shall be constructed so as to permit relative movement of the adjoining pipe sections with no reduction of water-tightness.

2.1.4.2 Joint Length

The joint length and the limiting angle defining the required capability of relative movement at each joint shall be no less than specified. Joint length refers to the permissible axial movement in the joint, and is defined as the maximum distance through which the spigot can move, relative to the bell or sleeve, from the fully engaged to the fully extended condition of the joint when the adjoining pipe sections are in parallel, concentric alignment. The joint is considered to be fully engaged when the spigot is inserted as far as it will go into the bell or sleeve, and fully extended when it is inserted the least amount that will insure full confinement of the gasket and complete water-tightness.

2.1.4.2.1 Limiting Angle

The limiting angle of the joint is the maximum deflection angle between adjoining pipe sections that the joints will permit before the outer surface of the spigot comes into direct contact with the inside of the mating bell or sleeve.

2.1.5 Gaskets

The pipe joint gaskets shall be endless rubber gaskets having a circular cross-sectional diameter conforming to the pipe manufacturer’s recommendation for the type and size of pipe furnished.

2.1.6 Joint Grout

Grout for sealing the joints shall be applied as shown on the drawings and shall conform to the requirements of ASTM C 1107.

2.1.7 Joint Mortar

Mortar for interior joint protection shall be a mix of 1 part portland cement, 1 part sand and water (quantity) for proper consistency.

2.2 BACKFILL

Backfill shall be made with suitable materials to the lines and grades shown on the drawings and as specified in Section 02221 EXCAVATION, FILL, BACKFILL AND EMBANKMENT FOR STRUCTURES

2.3 TESTS, INSPECTIONS, AND VERIFICATIONS

The concrete pressure pipe shall be tested, inspected and verified as meeting the requirements of ASTM C 497. Tests will be waived upon acceptance of the manufacturer's certification that similar materials have been subjected to the required tests and that the materials furnished meet the requirements specified.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Foundation

The Contractor shall perform excavation as indicated on the drawings and in accordance with Section 02221 EXCAVATION, FILL, BACKFILL AND EMBANKMENT FOR STRUCTURES. After completion of excavation and prior to installation of the pipe and any concrete placement, the excavation will be inspected by the Contracting Officer to ensure that suitable foundations or depths have been established.

3.1.2 Foundation Shaping

The bottom of the trench for the pipe shall be rounded to a depth $1/6$ of the pipe diameter so that the lower portion of the pipe bears on firm material. Earthwork in the vicinity of the trench shall be performed so that the ground surface is properly pitched to prevent water running into the excavated area. Water which has accumulated in the excavated area shall be removed.

3.1.3 Disposal

Suitable excavated material shall be stockpiled to the maximum extent practicable and used for backfill. Unsuitable materials shall be disposed of as specified in Section 02221 paragraph EXCAVATION, FILL, BACKFILL AND EMBANKMENT FOR STRUCTURES

3.1.4 Shoring

In the event the Contractor elects to excavate in a vertical manner in lieu of the sloped excavation shown, the Contractor shall sheet and shore as required for the protection of the work and for the safety of personnel.

3.2 INSTALLATION

The pipe, with fittings, shall be installed at the locations indicated. The Contractor shall provide facilities and take measures to install pipe in the dry.

3.2.1 Laying

Except where authorized, pipe shall be laid with bells facing upstream. Before lowering and while suspended, the pipe shall be inspected for defects. Defective material shall be rejected. Pipe shall be laid in compliance with the manufacturer's instructions.

3.2.2 Jointing: Lined Cylinder Concrete Pressure Pipe

The manufacturer's instructions shall be followed when lubricating and installing rubber gaskets. Joints shall comply with the manufacturer's instructions. The external annular space shall be filled with cement mortar or with a portland cement-filled polyurethane loop. The internal annular space shall be filled with cement mortar and struck off to insure a smooth and continuous surface between pipe sections.

3.3 PRESSURE TESTING

Prior to the placement of any concrete or earth fill around the conduit or filling of the pipe joints, the conduit shall be tested for leaks in the following manner: The ends of the conduits shall be plugged and a standpipe with a minimum diameter of 2 inches shall be attached to the upstream plug. The conduit shall be braced at each end to prevent slippage. The conduit and the standpipe shall be filled with water. The water level in the standpipe shall be maintained by continuous pumping to provide a 10-foot head above the invert of the upstream end of the conduit for the test period of not less than two hours. The pipe joints shall show no leakage. Damp spots developing on the surface of the pipe will not be considered as leakage. Any leaks that occur during this period shall be repaired by a method satisfactory to the Contracting Officer. After repair, the conduit shall be tested again as described above and the procedure shall be repeated until the conduit is accepted as watertight, by the Contracting Officer.

End of Section

DIVISION 2 - SITE WORK

SECTION 02714

DEWATERING

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SECTION 02714

DEWATERING

PART 1 GENERAL

1.1 SYSTEM DESCRIPTION

1.1.1 Dewatering

Dewatering defines the lowering of the ground water below the slopes and bottom of the excavation to ensure dry, firm working conditions and the reduction of safe levels of any hydrostatic uplift pressures in any confined foundation strata and/or aquifers which is necessary to ensure the stability and integrity of the foundation.

1.1.2 Dewatering System

Dewatering system defines the machinery, equipment, and appurtenances necessary for and related to the accomplishment of dewatering, and the collection and disposal of all surface water within the protected area. Protected area is defined as the area excavated for construction of the pump station, conduits, gate tower, stilling basin, and portions of the inlet and outlet channels.

1.1.3 Unwatering

Unwatering is defined as the process of removing all water within an excavation.

1.1.4 Rewatering

Rewatering is defined as the controlled process of placing water in the complete structure and/or excavation to its natural occurring elevation at a specified rate when the construction is completed and the dewatering system is no longer required.

1.2 SUBMITTALS

Government approval is required for all submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES;

SD-08 Statements

System Description; GA.

The Contractor shall submit details of his proposed dewatering facilities for review and approval.

SD-09 Reports

Initial Testing; FIO.

The Contractor shall initially test and evaluate the installed dewatering system and furnish results to the Government.

1.3 GENERAL

The work consists of designing, furnishing, installing, and operating a system to dewater the excavation required for constructing the pump station, conduits, gate tower, stilling basin, and portions of the inlet and outlet channels and maintaining these areas free from water during construction operations, monitoring the ground water and piezometric levels, rewatering the area under controlled conditions at the termination of the dewatering, having the capability for emergency flooding, and removing the system.

1.3.1 Permanent Work Under This Contract

All permanent work under this contract shall be carried on in areas free of water. The Contractor shall design, furnish, install, operate, and maintain such facilities necessary to accomplish the following;

- a. Collect and dispose of all surface water in the protected area regardless of source.
- b. Control and dispose of all surface water around the periphery of the excavation areas to prevent such water from entering the excavation.
- c. Lower and maintain the water table at least 3 feet below the bottom of the excavation and at least 3 feet below the side slopes.
- d. Install construction piezometers and monitor the phreatic surface and piezometric levels.
- e. Relieve excess hydrostatic pressures in the pervious sand stratum existing between approximately elevations 254 and 263 to prevent upheaval of, or any form of damage to, the foundation.
- f. Provide a system of dikes and ditches around the periphery of the excavation to route water away from the side slopes.

1.3.2 Design Requirements

The dewatering system shall be designed using accepted professional methods of engineering design consistent with the best current practice. The Contractor shall perform necessary tests and analyses of the ground-water quality and soil environment at the site to satisfy themselves that materials used in the system will not corrode or otherwise deteriorate to such an extent that the system will not perform satisfactorily during the life of the contract, and that adequate prevention and/or maintenance procedures are incorporated in the dewatering system design to prevent the clogging of the system due to the buildup of incrustation resulting from the deposition of dissolved minerals in the ground water and slime-forming organisms. Piezometers shall be as indicated in paragraph SYSTEM REQUIREMENTS.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION

3.1 SYSTEM REQUIREMENTS

The dewatering system shall be of a type and capacity to accomplish all requirements specified.

- a. The dewatering system shall be designed, installed and operated to dewater the excavation to a minimum elevation of 248 feet NGVD and capable of maintaining water levels at or below elevation 248 feet NGVD with a 25 year event on the Mississippi River or elevation 299 feet NGVD.
- b. The system shall be of such capacity that it will lower and maintain the free-water and piezometric levels as indicated in paragraph GENERAL. The system shall have sufficient capacity to accomplish this desired result allowing for normal variations in soil properties and foundation conditions.
- c. The water level shall be maintained continuously at or below the elevations specified above so that construction operations can be performed without interruption due to wet conditions.
- d. No upward or lateral flow of ground water into the work area will be permitted at any time. The dewatering system shall be designed, constructed, and operated at all times, including unwatering and rewatering so as to prevent movement and/or piping of the foundation, excavation slopes, and fill materials. The system shall be operated as necessary during dewatering, unwatering, and rewatering so as to maintain piezometric levels, within the dewatered area, at or beneath the elevation of the water level in the excavation.
- e. The system shall consist of wells, and/or wellpoints, pumps, sumps, sump pumps, ditches, and necessary appurtenances capable of lowering and maintaining the water table as specified in paragraph PERMANENT WORK UNDER THIS CONTRACT. The system shall be operated as required in paragraph "c" above to prevent flooding filter materials and fresh concrete; and shall be designed to control a rainfall intensity 6.6 inches in 24 hours and/or 2.5 inches per hour. Protection of all slopes will be required to prevent erosion under normal surface runoff and construction conditions.
- f. Initial unwatering of an excavation need not be accomplished by sumping alone, but may utilize sumping in addition to positive dewatering accomplished with a system meeting the requirements of paragraph "d" above. Initial unwatering shall at all times fulfill the requirements of paragraph "d" above.
- g. Rewatering of the area shall be accomplished by directing surface and ground water into the area. The dewatering system shall be kept operating at full capacity during such conditions, with dewatering effluent being directed into the excavation. No upward or vertical or lateral flow of ground water into the excavation will be permitted.
- h. Burying of headers will be allowed only in areas and to depths absolutely necessary for protection against damage at construction equipment crossings.
- i. Four construction piezometers will be required to monitor free water-surface elevations and

piezometric elevations to evaluate the effectiveness of the dewatering system in fulfilling the requirements specified. Piezometer locations shall be approved by the Contracting Officer and shall be in suitable arrangements and depths for determining the free water surface elevation and piezometric elevation over the area. The Contractor shall make a minimum of one reading per instrument, per 24-hour period, a minimum of 8 hours apart, based on a 7-day week. These piezometer readings shall be recorded on an approved form and reported to the Contracting Officer within 12 hours after they are obtained. If, in the opinion of the Contracting Officer, more frequent readings are required, the Contractor will be directed as to the number and time that these readings are required. If additional readings are directed, an equitable adjustment in the contract unit price for dewatering will be made.

- j. The system shall include mechanical means, such as an in-line venturi meter for measuring the total effluent of the dewatering system. Devices and techniques used in measurement shall be acceptable to the Contracting Officer. Initially, the Contractor shall make a minimum of one reading per instrument, per 24-hour period, a minimum of 8 hours apart, based on a 7-day week. These instrument readings shall be recorded on an approved form and reported to the Contracting Officer within 12 hours after they are obtained. If, in the opinion of the Contracting Officer, more frequent readings are required, the Contractor will be directed as to the number and time that these readings are required. If additional readings are directed, an equitable adjustment in the contract unit price for dewatering will be made.
- k. The system shall be designed, installed, and operated in a manner which will preclude removal of materials from the foundation by the pumping operation (hereafter referred to as "sanding"). After installation, each well or wellpoint segment shall be designed and constructed so as to permit periodic measuring of sanding characteristics of each well and/or wellpoint segment. Any well or wellpoint segment found sanding at a rate exceeding one (1) pint per 24 hours of pumping at any time during this contract shall be replaced in a manner acceptable to the Contracting Officer, and at no additional cost to the Government.

3.2 INITIAL TESTING

Upon installation of the system, the Contractor shall test and evaluate the completed system to demonstrate to the satisfaction of the Contracting Officer that the system is, in fact, capable of performing the intended dewatering operation as outlined. This testing shall include complete falling-head tests to be conducted on each piezometer. All test results and installation reports shall be recorded by the Contractor in full detail and copies furnished the Government.

3.3 REVIEW OF SYSTEM DESIGN AND PERFORMANCE

The Contractor shall submit to the Contracting Officer, for review and approval, details of his proposed dewatering facilities, including the type of system, planned layout and sizes of wells and/or well points, including screen diameter, lengths, and screen open areas, headers, including all lengths requiring burial, collectors, ditches, piezometers, sumps and pumps; capacities of stand-by pumping and power supply facilities; number, type, location, proposed method of installation, and proposed methods of testing of piezometers; facilities for measuring the flow of water pumped from the dewatering system; facilities and proposed schedule for monitoring of sanding; provisions for disposal of water from the dewatering system; provisions for handling and disposal of surface water; and plan of operation. This submittal shall include the design capacity of each well and/or wellpoint segment at the design stage, and shall be submitted no later than 60 days prior to installation of the system. The

Contracting Officer's review of the Contractor's proposed dewatering facilities will be for the purpose of determining

- a. the general design concept and layout of the system;
- b. the gross capacity of the system at the design stage of 299 ft. NGVD; and

The Contractor shall install the entire dewatering system submitted and shall make no reduction to the planned system without the prior written approval of the Contracting Officer. If, during the progress of the work, the installed dewatering system proves inadequate to meet the requirements specified, including piezometers, the Contractor shall, at his expense, furnish, install, and operate such additional dewatering facilities and/or make such changes, either in features of the system or the plan of operation, as may be necessary to perform the required dewatering in a satisfactory manner. Such changes and additions shall be approved in writing prior to being made.

3.4 OPERATION

The Contractor shall perform such dewatering and maintain the work areas in a dry condition as long as is necessary for the work under this contract. Once an area is dewatered, it shall be maintained in a dewatered condition until all work in that area is completed.

3.5 MAINTENANCE AND SERVICING

The Contractor shall be responsible for the maintenance, servicing, and repairs of the entire dewatering system and appurtenances during the life of the contract, including replacement of any and all wells, wellpoints, and piezometers found performing unsatisfactorily.

3.6 REMOVAL

The dewatering facilities required to maintain a dry condition within the protected area shall be maintained until completion of the work within the protected area, and then shall be completely removed after the rewatering process is completed. However no dewatering facilities of any kind shall be removed without prior approval. All wells, wellpoints, pumps, and appurtenances employed in the dewatering system and all materials other than earth shall remain the property of the Contractor and shall be removed from the site of the work. All holes shall be plugged with cement grout in a manner approved.

3.7 TESTS AND INSPECTIONS

The Contractor shall maintain detailed records of dewatering operations, including the following:

- a. piezometric elevation daily,
- b. time of operation of each pump,
- c. time of operation of each well or wellpoint segment,
- d. daily effluent discharge,
- e. daily sanding rates,
- f. problems encountered,
- g. proposed actions,
- h. any other pertinent data.

Copies of these records and tests, as well as records of corrective action taken, shall be furnished in accordance with SECTION 01451 CONTRACTOR QUALITY CONTROL.

End of Section

DIVISION 2-SITE WORK

SECTION 02930

SEEDING AND FERTILIZING

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SECTION 02930

SEEDING AND FERTILIZING

PART 1 GENERAL

1.1 SCOPE OF WORK

The work covered by this Section includes the labor, equipment, and materials necessary to prepare the seedbed, plant seed, fertilize, and water as required to establish a uniform turfgrass.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Seed

The seed mixture selected shall be State-certified seed of the latest season's crop and shall be delivered in original sealed packages bearing the producer's guaranteed analysis for percentages of mixtures, purity, germination, weed seed content, and inert material. Weed seed shall not exceed 1 percent by weight of the total mixture. Seed shall be labeled in conformance with applicable State seed laws. Seed that has become wet, moldy, or otherwise damaged will not be acceptable. Seed shall be planted at the rate per acre indicated in the Paragraph: SEEDING below.

2.1.2 Fertilizer

The fertilizer used shall be commercial grade, free flowing, and uniform in composition. Fertilizer shall be 13-13-13 Grade.

2.1.3 Topsoil

Topsoil shall be free from large clumps, roots, rocks, and other debris. Topsoil may be obtained from off-site or on-site source(s) and shall be acceptable to the Contracting Officer.

2.1.4 Mulch

Mulch shall be free from weeds, mold, and other deleterious materials.

2.1.5 Water

Water shall be free from oil, acid, alkali, salt, and other substances harmful to the growth of grass. The water source shall be subject to approval prior to use.

PART 3 EXECUTION

3.1 GENERAL

Seeding and fertilizing operations shall be performed only during periods when beneficial results can be obtained. The work shall be stopped when drought, excessive moisture, or other unsatisfactory conditions prevail, or when directed. When special conditions warrant a variance to the turfing operations, proposed times shall be submitted and approved prior to proceeding. Turfgrass establishment shall be accomplished on embankments, berms, unpaved, graded and disturbed areas.

3.2 SITE PREPARATION

3.2.1 Seedbed Preparation

Areas to be seeded shall be cultivated to a depth of at least 4 inches. The seedbeds shall be cultivated sufficiently to reduce the soil to a state of good tilth where the existing soil can bond with the hydromulching application. Large roots, rocks, and other debris shall be removed.

3.2.2 Topsoil Application

Topsoil shall be applied to new embankment areas and disturbed areas. After the subgrade soil has been prepared, topsoil shall be spread evenly to a depth of 4 inches by an approved method. The finish surface of the topsoil shall be evenly graded, conform to the finished grade, and shall be free from hollows or other inequalities, stones, sticks, and other extraneous matter. The Contractor shall be prepared to immediately install grass seeding and fertilizing upon completed and accepted finish grade.

3.3 SEEDING

Prior to seeding, previously prepared seedbed areas that are compacted or damaged by interim rain, traffic, or other cause, shall be reworked to restore the ground condition previously specified. Seeding operations shall not take place when weather conditions prevent uniform seed distribution. Seed shall be applied as follows:

<u>Planting Window</u>	<u>Pure Live Seed</u>
October 1 to March 31	KY-31 Tall Fescue Hulled Common Bermudagrass Unhulled Common Bermudagrass
April 1 to Sept. 30	Foxtail Millet Hulled Common Bermudagrass

NOTE: Pure Live Seed = % Purity Times (% Germination + % Hard Seed) divided by 100.

3.3.1 Applying Seed

3.3.1.1 Hydroseeding

Seed and fertilizer shall be added to water and thoroughly mixed. Wood cellulose fiber or shredded paper fiber mulch shall be added at the rates recommended by the manufacturer after the seed, fertilizer, and water have been thoroughly mixed to produce a homogeneous slurry. Slurry shall be uniformly applied under pressure over the entire area. The hydroseeded area shall not be rolled.

3.3.1.2 Protection of Seeded Areas

Immediately after seeding, the area shall be protected against equipment traffic or other use as directed. Sloped areas shall be protected from erosion by the application of an asphalt-tacked mulch or other approved methods.

3.4 TURF ESTABLISHMENT

3.4.1 Turf Establishment

A satisfactory stand of turfgrass from the seeding and fertilizing operation is defined as a minimum of twenty (20) warm-season perennial grass plants per square foot and the area having less than the minimum plants be not more than 5 percent of total area being turfed. Areas 100 square feet or larger, that are not covered by a satisfactory stand of grass shall be re-planted. A satisfactory stand of turfgrass will not be accepted until a uniform density coverage of warm-season perennial grass has been established that satisfies the "final stabilization" requirement of the National Pollutant Discharge Elimination System (NPDES). The Environmental Protection Agency NPDES regulations describe "final stabilization" as a uniform warm-season perennial vegetative cover with a density of 70 percent.

3.4.2 Final Inspection

A final inspection shall be held by the Contracting Officer to make note of deficiencies in seeding coverage. Areas not properly germinated shall be repaired by the Contractor.

End of Section

DIVISION 3 - CONCRETE

SECTION 03101

FORMWORK FOR CONCRETE

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SECTION 03101

FORMWORK FOR CONCRETE

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

ACI INTERNATIONAL (ACI)

ACI 034794 (1994) Guide for Formwork for Concrete

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 31 (1996) Making and Curing Concrete Test Specimens in the Field

ASTM C 39 (1996) Compressive Strength of Cylindrical Concrete Specimens

ASTM C 1077 (1998) Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation

DEPARTMENT OF COMMERCE (DOC)

DOC PS 1-95 (1995) Construction and Industrial Plywood

1.2 DESIGN REQUIREMENTS

The design, engineering, and construction of the formwork shall be the responsibility of the Contractor. The formwork shall be designed for anticipated live and dead loads and shall comply with the tolerances specified in Section 03301 CAST-IN-PLACE STRUCTURAL CONCRETE, paragraph CONSTRUCTION TOLERANCES. The formwork shall be designed as a complete system with consideration given to the effects of cementitious materials and mixture additives such as fly ash, cement type, plasticizers, accelerators, retarders, air entrainment, and others. The adequacy of formwork design and construction shall be monitored prior to and during concrete placement as part of the Contractor's approved Quality Control Plan.

1.3 SUBMITTALS

Government approval is required for all submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Materials; FIO.

Manufacturer's literature shall be submitted for plywood, concrete form hard board, form accessories, prefabricated forms, form coating.

SD-04 Drawings

Shop Drawings; FIO.

Drawings and design computations for all formwork required shall be submitted at least 30 days either before fabrication on-site or before delivery of prefabricated forms.

SD-08 Statements

Shop Drawings; FIO.

If reshoring is permitted, the method, including location, order, and time of erection and removal shall also be submitted for review.

SD-09 Reports

Inspection; FIO.

The Contractor shall submit field inspection reports for concrete forms and embedded items.

Formwork Not Supporting Weight of Concrete; GA.

If forms are to be removed in less than 24 hours on formwork not supporting weight of concrete, the evaluation and results of the control cylinder tests shall be submitted to the Contracting Officer and approved before the forms are removed.

1.4 SHOP DRAWINGS

The shop drawings and data submitted shall include the type, size, quantity, and strength of all materials of which the forms are made, the plan for jointing of facing panels, details affecting the appearance, and the assumed design values and loading conditions.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Forms and Form Liners

Forms and form liners shall be fabricated with facing materials that will produce a finish meeting the specified construction tolerance requirements and the following surface classifications as defined in ACI 034794.

2.1.1.1 Class "B" Finish

This class of finish shall apply to all surfaces exposed to view in the finished structure except those specified to receive Class C or Class D. The form facing material shall be composed of tongue-and-groove or shiplap lumber, plywood conforming to DOC PS1-95, Grade B-B concrete form, tempered concrete form hard board or steel. Steel lining on wood sheathing will not be permitted.

2.1.1.2 Class "C" Finish

This class of finish shall apply to formed suction intake surfaces and other curved surfaces. The form facing may be either tongue-and-groove lumber, plywood, concrete form hard board or steel. Wood form facing for curved or warped surfaces shall be composed of splines of lumber which can be bent to the required shape without splitting or cracking.

2.1.1.3 Class "D" Finish

This class of finish shall apply to all surfaces not exposed to view in the finished structures. The form facing may be of wood or steel.

2.1.2 Form Coating

Form coating shall be commercial formulation that will not bond with, stain, cause deterioration, or any other damage to concrete surfaces. The coating shall not impair subsequent treatment of concrete surfaces depending upon bond or adhesion nor impede the wetting of surfaces to be cured with water or curing compounds. If special form liners are to be used, the Contractor shall follow the recommendation of the form coating manufacturer.

2.2 ACCESSORIES

Ties and other similar form accessories to be partially or wholly embedded in the concrete shall be of a commercially manufactured type. After the ends or end fasteners have been removed, the embedded portion of metal ties shall terminate not less than 2 inches from any concrete surface either exposed to view or exposed to water. Plastic snap ties may be used in locations where the surface will not be exposed to view. Form ties shall be constructed so that the ends or end fasteners can be removed without spalling the concrete.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Form Construction

Forms shall be constructed true to the structural design and required alignment. The form surface and joints shall be mortar tight and supported to achieve safe performance during construction, concrete placement, and form removal. The Contractor shall continuously monitor the alignment and stability of the forms during all phases to assure the finished product will meet the required surface classes specified in paragraph FORMS AND FORM LINERS and tolerances specified in paragraph DESIGN REQUIREMENTS. Failure of any supporting surface either due to surface texture, deflection or form collapse shall be the responsibility of the Contractor as will the replacement or correction of unsatisfactory surfaces. When forms for continuous surfaces are placed in successive units, care shall be taken to fit the forms over the completed surface to obtain accurate alignment of the surface and to

prevent leakage of mortar. Forms shall not be re-used if there is any evidence of defects which would impair the quality of the resulting concrete surface. All surfaces of used forms shall be cleaned of mortar and any other foreign material before reuse.

3.1.2 Chamfering

All exposed joints, edges and external corners shall be chamfered by molding placed in the forms unless the drawings specifically state that chamfering is to be omitted or as otherwise specified. Chamfered joints shall not be permitted where earth or rockfill is placed in contact with concrete surfaces. Chamfered joints shall be terminated twelve inches outside the limit of the earth or rockfill so that the end of the chamfers will be clearly visible.

3.1.3 Coating

Forms for exposed or painted surfaces shall be coated with form oil or a form-release agent before the form or reinforcement is placed in final position. The coating shall be used as recommended in the manufacturer's instructions. Forms for unexposed surfaces may be wet with water in lieu of coating immediately before placing concrete, except that, in cold weather when freezing temperatures are anticipated, coating shall be mandatory. Surplus coating on form surfaces and coating on reinforcing steel and construction joints shall be removed before placing concrete.

3.2 FORM REMOVAL

Forms shall not be removed without approval. The minimal time required for concrete to reach a strength adequate for removal of formwork without risking the safety of workers or the quality of the concrete depends on a number of factors including, but not limited to, ambient temperature, concrete lift heights, type and amount of concrete admixture, and type and amount of cementitious material in the concrete. It is the responsibility of the Contractor to consider all applicable factors and leave the forms in place until it is safe to remove them. In any case forms shall not be removed unless the minimum compressive strength requirements below are met, except as otherwise directed or specifically authorized. When conditions are such as to justify the requirement, forms will be required to remain in place for a longer period. All removal shall be accomplished in a manner which will prevent damage to the concrete and ensure the complete safety of the structure. Where forms support more than one element, the forms shall not be removed until the form removal criteria are met by all supported elements. Form removal shall be scheduled so that all necessary repairs can be performed as specified in Section 03301 CAST-IN-PLACE STRUCTURAL CONCRETE, paragraph title "Formed Surface Repair". Evidence that concrete has gained sufficient strength to permit removal of forms shall be determined by tests on control cylinders. All control cylinders shall be stored in the structure or as near the structure as possible so they receive the same curing conditions and protection methods as given those portions of the structure they represent. Control cylinders shall be removed from the molds at an age of no more than 24 hours. All control cylinders shall be prepared and tested in accordance with ASTM C 31 and ASTM C 39 at the expense of the Contractor by an independent laboratory that complies with ASTM C 1077 and shall be tested within 4 hours after removal from the site.

3.2.1 Formwork Not Supporting Weight of Concrete

Formwork for walls, columns, sides of beams, gravity structures, and other vertical type formwork not supporting the weight of concrete shall not be removed in less than 24 hours after concrete placement is completed. Form removal before 24 hours will be allowed for floor slabs on grade, sidewalks, and driveways provided the ambient temperature during this period has not fallen below 50 degrees F at any time since placement and evidence from compressive tests on field-cured concrete control

cylinders indicates that the concrete has attained a compressive strength of at least 3000 psi. Control cylinders shall be prepared for each set of forms to be removed before 24 hours.

3.2.2 Formwork Supporting Weight of Concrete

Formwork supporting weight of concrete and shoring shall not be removed until structural members have acquired sufficient strength to safely support their own weight and any construction or other superimposed loads to which the supported concrete may be subjected. As a minimum, forms shall be left in place until control concrete test cylinders indicate evidence the concrete has attained at least 90 percent of the compressive strength required for the structure in accordance with the quality and location requirements of Section 03301 CAST-IN-PLACE STRUCTURAL CONCRETE, paragraph titled "Concrete Strength".

3.3 INSPECTION

Forms and embedded items shall be inspected in sufficient time prior to each concrete placement by the Contractor in order to certify to the Contracting Officer that they are ready to receive concrete. The results of each inspection shall be reported in writing.

End of Section

DIVISION 3 - CONCRETE

SECTION 03150

EXPANSION, CONTRACTION, WATERSTOPS AND CONSTRUCTION JOINTS IN CONCRETE

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SECTION 03150

EXPANSION, CONTRACTION, WATERSTOPS AND CONSTRUCTION JOINTS IN CONCRETE

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 1751	(1997) Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D 1752	(1996)e1 Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM D 2628	(1998) Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements
ASTM D 2835	(1993) Lubricant for Installation of Preformed Compression Seals in Concrete Pavements

CORPS OF ENGINEERS (COE)

COE CRD-C 513	(1974) Corps of Engineers Specifications for Rubber Waterstops
COE CRD-C 572	(1974) Corps of Engineers Specifications for Polyvinylchloride Waterstops

FEDERAL SPECIFICATIONS (FS)

FS TT-S-00227	(Rev E; Am 3) Sealing Compound: Elastomeric Type, Multi-Component (for Caulking, Sealing, and Glazing in Buildings and Other Structures)
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1.2 SUBMITTALS

Government approval is required for all submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-08 Statements

Splicing Waterstops; GA.

Procedures for splicing waterstops shall be submitted.

SD-09 Reports

Premolded Expansion Joint Filler Strips; FIO. Compression Seals and Lubricant; FIO.

Certified manufacturer's test reports shall be provided for premolded expansion joint filler strips, compression seals and lubricant, and metallic waterstops to verify compliance with applicable specification.

SD-14 Samples

Field Molded Sealants and Primer; FIO.

One gallon of field-molded sealant and one quart of primer (when primer is recommended by the sealant manufacturer) shall be provided for testing.

Waterstops; FIO.

Waterstop materials and splice samples shall be submitted for inspection and testing and shall be identified to indicate manufacturer, type of material, size and quantity of material and shipment represented. Each materials sample shall be a piece not less than 12 inches long cut from each 200 feet of finished waterstop furnished, but not less than a total of four linear feet of each type and size furnished. For spliced segments of waterstops to be installed in the work, one spliced sample of each size and type for every 50 splices made in the factory and every 10 splices made at the job site shall be furnished for inspection and testing. The spliced samples shall be made using straight run pieces with the splice located at the mid-length of the sample and finished as required for the installed waterstop. The total length of each spliced sample shall be not less than 12 inches long.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Premolded Expansion Joint Filler Strips

Premolded expansion joint filler strips shall conform to ASTM D 1751 or ASTM D 1752, Type I, or resin impregnated fiberboard conforming to the physical requirements of ASTM D 1752.

2.1.2 Non-Metallic Waterstops

Rubber waterstops shall conform to COE CRD-C 513. Polyvinylchloride waterstops shall conform to COE CRD-C 572.

2.2 TESTS, INSPECTIONS, AND VERIFICATIONS

2.2.1 Materials Tests

2.2.1.1 Non-Metallic Waterstops

Contractor shall submit certificate to Contracting Officer from manufacturer verifying compliance with specification requirements.

2.2.2 Splicing Waterstops

2.2.2.1 Procedure and Performance Qualifications

Procedure and performance qualifications for splicing waterstops shall be demonstrated in the presence of the Contracting Officer.

2.2.2.2 Non-Metallic Waterstops

Procedure and performance qualifications for splicing non-metallic waterstops shall be demonstrated by the manufacturer at the factory and the Contractor at the job site by each making three spliced samples of size and type of finished waterstop.

PART 3 EXECUTION

3.1 INSTALLATION

Joint locations and details, including materials and methods of installation of joint fillers and waterstops, shall be as specified, as shown, and as directed.

3.1.1 Expansion Joints

Premolded filler strips be installed where shown in joints of conduits. Sealing of joints is not required.

3.1.2 Waterstops

Waterstops shall be carefully and correctly positioned during installation to eliminate faulty installation that may result in joint leakage. All waterstops shall be installed so as to form a continuous watertight diaphragm in each joint. Adequate provision shall be made to support and protect the waterstops during the progress of work. Any waterstop punctured or damaged shall be replaced or repaired at the Contractor's expense. The concrete shall be thoroughly consolidated in the vicinity of the waterstop. Suitable guards shall be provided to protect exposed projecting edges and ends of partially embedded waterstops from damage when concrete placement has been discontinued.

3.1.2.1 Splices

Joints in waterstops shall be spliced together by qualified splicers using the approved splicing procedures to form a continuous watertight diaphragm. Splices shall be as follows:

- a. Non-Metallic Waterstops - All splices shall be made on a bench in a temporary shop provided at the site of the installation or at the manufacturer's plant. A miter guide and portable power saw shall be used to cut the ends to be joined to insure good alignment and

contact between joined surfaces. Continuity of the characteristic features of the cross section of the waterstop (ribs, tabular center axis, protrusions and the like) shall be maintained across the splice.

- b. Rubber Waterstops - Splices shall be vulcanized in accordance with the approved procedure.
- c. Polyvinylchloride Waterstops - Splices shall be made by heat sealing the adjacent surfaces in accordance with the approved procedure. A thermostatically controlled electrical heat source shall be used to make all splices. The correct temperature at which splices should be made will differ with the material concerned but the applied heat should be sufficient to melt but not char the plastic. Waterstops shall be reformed at splices with a remolding iron with ribs or corrugations to match the pattern of the waterstop. The spliced area, when cooled and bent by hand in as sharp an angle as possible, shall show no sign of separation.

End of Section

DIVISION 3 - CONCRETE

SECTION 03200

CONCRETE REINFORCEMENT

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SECTION 03200

CONCRETE REINFORCEMENT

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

ACI INTERNATIONAL (ACI)

ACI 031895	(1995) Building Code Requirements for Structural Concrete and Commentary
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AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 53	(1997) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A 82	(1997) Steel Wire, Plain, for Concrete Reinforcement
ASTM A 184	(1996) Fabricated Deformed Steel Bar Mats for Concrete Reinforcement
ASTM A 185	(1997) Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
ASTM A 497	(1997) Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement
ASTM A 499	(1997)e1 Steel Bars and Shapes, Carbon Rolled from "T" Rails
ASTM A 615	(1996a)e1 Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM A 675	(1995)e1 Steel Bars, Carbon, Hot-Wrought, Special Quality, Mechanical Properties
ASTM A 706	(1996b) Low-Alloy Steel Deformed Bars for Concrete Reinforcement

CONCRETE REINFORCING STEEL INSTITUTE (CRSI)

CRSI MSP-1	(1990) Manual of Standard Practice
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1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-04 Drawings

Concrete Reinforcement System; GA.

Detail drawings showing reinforcing steel placement, schedules, sizes, grades, and splicing and bending details. Drawings shall show support details including types, sizes and spacing.

SD-13 Certificates

Reinforcing Steel; GA.

Certified copies of mill reports attesting that the reinforcing steel furnished meets the requirements specified, prior to the installation of reinforcing steel.

1.3 DELIVERY AND STORAGE

Reinforcement and accessories shall be stored off the ground on platforms, skids, or other supports.

PART 2 PRODUCTS

2.1 DOWELS

Dowels shall conform to ASTM A 675, Grade 80, or ASTM A 499. Steel pipe conforming to ASTM A 53, Schedule 80, may be used as dowels provided the ends are closed with metal or plastic inserts or with mortar.

2.2 FABRICATED BAR MATS

Fabricated bar mats shall conform to ASTM A 184.

2.3 REINFORCING STEEL

Reinforcing steel shall be deformed bars conforming to ASTM A 615 or ASTM A 706, grades and sizes as indicated. Because of special seismic design criteria the maximum field strength of bars shall be 75 ksi. Cold drawn wire used for spiral reinforcement shall conform to ASTM A 82.

2.4 WELDED WIRE FABRIC

Welded wire fabric shall conform to ASTM A 185 or ASTM A 497.

2.5 WIRE TIES

Wire ties shall be 16 gauge or heavier black annealed steel wire.

2.6 SUPPORTS

Bar supports for formed surfaces shall be designed and fabricated in accordance with CRSI MSP-1 and shall be steel or precast concrete blocks. Precast concrete blocks shall have wire ties and shall be not less than 4 inches square when supporting reinforcement on ground. Precast concrete block shall have compressive strength equal to that of the surrounding concrete. Where concrete formed surfaces will be exposed to weather or where surfaces are to be painted, steel supports within 1/2 inch of concrete surface shall be galvanized, plastic protected or of stainless steel. Concrete supports used in concrete exposed to view shall have the same color and texture as the finish surface. For slabs on grade, supports shall be precast concrete blocks, plastic coated steel fabricated with bearing plates, or specifically designed wire-fabric supports fabricated of plastic.

PART 3 EXECUTION

3.1 REINFORCEMENT

Reinforcement shall be fabricated to shapes and dimensions shown and shall conform to the requirements of ACI 031895. Reinforcement shall be cold bent unless otherwise authorized. Bending may be accomplished in the field or at the mill. Bars shall not be bent after embedment in concrete. Safety caps shall be placed on all exposed ends of vertical concrete reinforcement bars that pose a danger to life safety. Wire tie ends shall face away from the forms.

3.1.1 Placement

Reinforcement shall be free from loose rust and scale, dirt, oil, or other deleterious coating that could reduce bond with the concrete. Reinforcement shall be placed in accordance with ACI 031895 at locations shown plus or minus one bar diameter. Reinforcement shall not be continuous through expansion joints and shall be as indicated through construction or contraction joints. Concrete coverage shall be as indicated or as required by ACI 031895. If bars are moved more than one bar diameter to avoid interference with other reinforcement, conduits or embedded items, the resulting arrangement of bars, including additional bars required to meet structural requirements, shall be approved before concrete is placed.

3.1.2 Splicing

Splices of reinforcement shall conform to ACI 031895 and shall be made only as required or indicated. Splicing shall be by lapping or by mechanical butt connection; except that lap splices shall not be used for bars larger than No. 11 unless otherwise indicated. Lapped bars shall be placed in contact and securely tied or spaced transversely apart to permit the embedment of the entire surface of each bar in concrete. Lapped bars shall not be spaced farther apart than one-fifth the required length of lap or 6 inches. Mechanical butt splices shall be in accordance with the recommendation of the manufacturer of the mechanical splicing device. Butt splices shall develop 125 percent of the specified minimum yield tensile strength of the spliced bars or of the smaller bar in transition splices. Bars shall be flame dried before butt splicing. Adequate jigs and clamps or other devices shall be provided to support, align, and hold the longitudinal centerline of the bars to be butt spliced in a straight line.

3.2 WELDED-WIRE FABRIC

Welded-wire fabric shall be placed in slabs as indicated. Fabric placed in slabs on grade shall be continuous between expansion, construction, and contraction joints. Fabric placement at joints shall be as indicated. Lap splices shall be made in such a way that the overlapped area equals the distance

between the outermost crosswires plus 2 inches. Laps shall be staggered to avoid continuous laps in either direction. Fabric shall be wired or clipped together at laps at intervals not to exceed 4 feet. Fabric shall be positioned by the use of supports.

3.3 DOWELS

Dowels shall be installed in slabs on grade at locations indicated and at right angles to joint being doweled. Dowels shall be accurately positioned and aligned parallel to the finished concrete surface before concrete placement. Dowels shall be rigidly supported during concrete placement. One end of dowels shall be coated with a bond breaker.

End of Section

DIVISION 3 - CONCRETE

SECTION 03301

CAST-IN-PLACE STRUCTURAL CONCRETE

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SECTION 03301

CAST-IN-PLACE STRUCTURAL CONCRETE

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

ACI INTERNATIONAL (ACI)

ACI 011790	(1990; Errata) Standard Tolerances for Concrete Construction and Materials
ACI 211191	(1991) Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
ACI 021489	(1977; R 1989) Evaluation of Strength Test Results of Concrete
ACI 030591	(1991) Hot Weather Concreting
ACI 031892	(1992; Rev 1992; Errata) Building Code Requirements for Reinforced Concrete

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 31	(1996) Making and Curing Concrete Test Specimens in the Field
ASTM C 33	(1997) Concrete Aggregates
ASTM C 39	(1996) Compressive Strength of Cylindrical Concrete Specimens
ASTM C 40	(1997) Organic Impurities in Fine Aggregates for Concrete
ASTM C 87	83(1995)e1 Effect of Organic Impurities in Fine Aggregate on Strength of Mortar
ASTM C 94	(1998) Ready-Mixed Concrete
ASTM C 117	(1995) Materials Finer Than 75 micrometer (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C 123	(1996)e1 Lightweight Pieces in Aggregate

ASTM C 127	88(1993)e1 Specific Gravity and Absorption of Course Aggregate
ASTM C 128	(1997) Specific Gravity and Absorption of Fine Aggregate
ASTM C 131	(1996) Resistance to Degradation of Small-Size Course Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 136	(1996a) Sieve Analysis of Fine and Coarse Aggregates
ASTM C 142	(1997) Clay Lumps and Friable Particles in Aggregates
ASTM C 143	(1997) Slump of Hydraulic Cement Concrete
ASTM C 150	(1997a) Portland Cement
ASTM C 171	(1997a) Sheet Materials for Curing Concrete
ASTM C 172	(1997) Sampling Freshly Mixed Concrete
ASTM C 192	(1995) Making and Curing Concrete Test Specimens in the Laboratory
ASTM C 231	(1997) Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 260	(1991/1997a) Air-Entraining Admixtures for Concrete
ASTM C 295	(1990) Petrographic Examination of Aggregates for Concrete
ASTM C 309	(1997) Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C 494	(1998) Chemical Admixtures for Concrete
ASTM C 535	(1996)e1 Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 566	(1997) Total Moisture Content of Aggregate by Drying
ASTM C 618	(1998) Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete
ASTM C 666	(1997) Resistance of Concrete to Rapid Freezing and Thawing
ASTM C 881	(1990) Epoxy-Resin-Base Bonding Systems for Concrete

ASTM C 1017	(1997) Chemical Admixtures for Use in Producing Flowing Concrete
ASTM C 1059	(1991) Latex Agents for Bonding Fresh to Hardened Concrete
ASTM C 1064	84(1993) Temperature of Freshly Mixed Portland Cement Concrete
ASTM C 1077	(1998) Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation
ASTM C 1107	(1997) Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM D 75	(1997) Sampling Aggregates

CORPS OF ENGINEERS (COE)

COE CRD-C 94	(1995) Specifications for Surface Retarders
COE CRD-C 104	(1980) Method of Calculation of the Fineness Modulus of Aggregate
COE CRD-C 114	(1994) Test Method for Soundness of Aggregates by Freezing and Thawing of Concrete Specimens
COE CRD-C 130	(1989) Estimating Scratch Hardness of Coarse Aggregate Particles
COE CRD-C 143	(1962) Specifications for Meters for Automatic Indication of Moisture in Fine Aggregate
COE CRD-C 318	(1972) Cloth, Burlap, Jute (or Kenaf)
COE CRD-C 400	(1963) Requirements for Water for Use in Mixing or Curing Concrete
COE CRD-C 521	(1981) Standard Test Method for Frequency and Amplitude of Vibrators for Concrete

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST HB 44	(1999) NIST Handbook 44: Specifications, Tolerances, and other Technical Requirements for Weighing and Measuring Devices
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NATIONAL READY-MIXED CONCRETE ASSOCIATION (NRMCA)

NRMCA CPMB 100	(1990) Concrete Plant Standards
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1.2 SUBMITTALS

Government approval is required for all submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES.

SD-01 Data

Concrete Mixture Proportioning; FIO.

Concrete mixture proportions shall be determined by the Contractor, in accordance with the requirements in paragraph CONCRETE MIXTURE PROPORTIONING, and submitted for review. The concrete mixture quantities of all ingredients per cubic yard and nominal maximum coarse aggregate size that will be used in the manufacture of each quality of concrete shall be stated. Proportions shall indicate the mass of cement, pozzolan, and water; the mass of aggregates in a saturated surface-dry condition; and the quantities of admixtures. The submission shall be accompanied by test reports from a laboratory complying with ASTM C 1077 which show that proportions thus selected will produce concrete of the qualities indicated. No substitution shall be made in the source or type of materials used in the work without additional tests to show that the quality of the new materials and concrete are satisfactory.

Batch Plant; FIO, Ready-Mix Plant, FIO.

The Contractor shall submit batch plant data or Ready Mix Plant data to the Contracting Officer for review for conformance with applicable specifications. Contractor may choose either source subject to conformance with specifications.

Concrete Mixers; FIO.

The Contractor shall submit concrete mixer data which includes the make, type, and capacity of concrete mixers proposed for mixing concrete in conformance with the paragraphs CAPACITY and CONCRETE MIXERS.

Conveying Equipment and Methods; FIO.

The conveying equipment and methods for transporting, handling, and depositing the concrete shall be submitted for review by the Contracting Officer for conformance with paragraphs CAPACITY and CONVEYING EQUIPMENT.

Placing Equipment and Methods; FIO.

All placing equipment and methods shall be submitted for review by the Contracting Officer for conformance with paragraph CAPACITY.

SD-08 Statements

Testing Technicians; FIO. Concrete Construction Inspector; FIO.

The Contractor shall submit statements that the concrete testing technicians and the concrete inspectors meet the requirements of paragraph TESTS AND INSPECTIONS.

Construction Joint Treatment; GA.

The method and equipment proposed for joint cleanup and waste disposal shall be submitted for review and approval for conformance with paragraph CONSTRUCTION JOINT TREATMENT.

Curing and Protection; GA.

The curing medium and methods to be used shall be submitted for review and approval for conformance with paragraph CURING AND PROTECTION.

Cold-Weather Placing; GA.

If concrete is to be placed under cold-weather conditions, the proposed materials, methods, and protection meeting the requirements of paragraph COLD-WEATHER PLACING shall be submitted for approval.

Hot-Weather Placing; GA.

If concrete is to be placed under hot-weather conditions, the proposed materials and methods, meeting the requirements of paragraph HOT-WEATHER PLACING and paragraph FINISHING, shall be submitted for review and approval.

SD-09 Reports

Aggregate Quality; FIO.

Aggregate quality tests shall be submitted at least 30 days prior to start of concrete placement, in accordance with paragraph QUALITY OF AGGREGATES.

Uniformity of Concrete Mixing; FIO.

The results of the initial mixer uniformity tests as required in paragraph MIXER UNIFORMITY shall be submitted at least 5 days prior to the initiation of placing.

Tests and Inspections; FIO.

Test results and inspection reports shall be submitted daily and weekly as required in paragraph REPORTS.

SD-13 Certificates

Cementitious Materials; FIO.

Cementitious Materials, including Cement and Pozzolan will be accepted on the basis of the manufacturer's certification of compliance, accompanied by mill test reports that materials meet the requirements of the specification under which they are furnished. Certification and mill test reports shall be from samples taken from the particular lot furnished. No cementitious materials shall be used until notice of acceptance has been given by the Contracting Officer. Cementitious materials will be subject to check testing from samples obtained at the source, at transfer points, or at the project site, as scheduled by the Contracting Officer, and such sampling will be by or under the supervision of the

Government at its expense. Material not meeting specifications shall be promptly removed from the site of work.

Impervious-Sheet Curing Materials; FIO.

Impervious-Sheet Curing Materials shall be certified for compliance with all specification requirements.

Air-Entraining Admixture; FIO.

Air-Entraining Admixture shall be certified for compliance with all specification requirements.

Other Chemical Admixtures; FIO.

Other Chemical Admixtures shall be certified for compliance with all specification requirements.

Membrane-Forming Curing Compound; FIO.

Membrane-Forming Curing Compound shall be certified for compliance with all specification requirements.

Epoxy Resin; FIO. Latex Bonding Compound; FIO.

Epoxy Resin and Latex Bonding Compound shall be certified for compliance with all specification requirements.

Nonshrink Grout; FIO.

Descriptive literature of the Nonshrink Grout proposed for use shall be furnished together with a certificate from the manufacturer stating that it is suitable for the application or exposure for which it is being considered.

SD-14 Samples

Aggregates; FIO. Cementitious Materials, Admixtures, and Curing Compound; GA.

Samples of materials for government testing and approval shall be submitted as required in paragraph GOVERNMENT TESTING AND SAMPLING.

1.3 GOVERNMENT TESTING AND SAMPLING

The Government may sample and test aggregates and concrete to determine compliance with the specifications. The Contractor shall provide facilities and labor as may be necessary for procurement of representative test samples. Samples of aggregates will be obtained at the point of batching in accordance with ASTM D 75. Concrete will be sampled in accordance with ASTM C 172.

1.4 DESIGN REQUIREMENTS

1.4.1 General

All concrete work shall conform to applicable provisions of ACI 031892.

1.4.2 Concrete Strength

Specified compressive strength f'_c shall be as follows:

COMPRESSIVE STRENGTH (PSI)	STRUCTURE OR PORTION OF STRUCTURE
a. 4,000 @ 28 days	1. Pump Station Base Slab 2. Walls & External Slab 3. Superstructure Columns & Beams 4. Stilling Basin 5. Outfall Conduits 6. Gate Tower Structure 7. Intake Monolith & Retaining Walls
b. 3,000 @ 28 days	1. Exterior Slabs on grade 2. Site Retaining Walls

1.4.3 Maximum Water-Cement (W/C) Ratio

Maximum W/C shall be as follows:

WATER-CEMENT RATIO, BY MASS	STRUCTURE OR PORTION OF STRUCTURE
0.40	All 4000 psi concrete
0.45	All 3000 psi concrete

(These W/C's may cause higher strengths than that required by paragraph CONCRETE STRENGTH.)

1.5 CONSTRUCTION TOLERANCES

1.5.1 General

The definitions of the terms used in the following tables shall be as defined in ACI 011790. Level and grade tolerance measurements of slabs shall be made as soon as possible after finishing. When forms or shoring are used, the measurements shall be made prior to removal. Tolerances are not cumulative. The most restrictive tolerance controls. Tolerances shall not extend the structure beyond legal boundaries. Except as specified otherwise, plus tolerance increases the amount or dimension to which it applies, or raises a level alignment, and minus tolerance decreases the amount or dimension to which it applies, or lowers a level alignment. A tolerance without sign means plus or minus. Where only one signed tolerance is specified, there is no limit in the other direction.

TOLERANCES FOR FOUNDATIONS

(1) Lateral alignment

Eccentricity measured from the
center of gravity of footing
as cast to the center of gravity
as specified; 0.02 times width
of footing in direction of
misplacement but not more than 2 in.

Supporting masonry construction	1/2 in.
(2) Level alignment	
Top of footings supporting masonry	1/2 in.
Top of other footings	+1/2 in.
.....	-2 in.
(3) Cross-sectional dimensions	
Horizontal dimension of formed members	+2 in.
.....	-1/2 in.
Horizontal dimensions of unformed members cast against soil	
2 ft or less	+3 in.
.....	-1/2 in.
Greater than 2 ft but less than 6 ft	+6 in.
.....	-1/2 in.
Over 6 ft	+12 in.
.....	-1/2 in.
Vertical dimension (thickness)	-5 percent
(4) Relative alignment	
Slope of footing side and top surfaces with respect to the specified plane	1 in. per 10 ft

TOLERANCES FOR CAST-IN-PLACE REINFORCED CONCRETE FOR BUILDINGS

(1) Vertical alignment	
For heights 100 ft or less	
Lines, surfaces, and arrises	1 in.
Outside corner of exposed corner columns and control joint grooves in concrete exposed to view	1/2 in.

For heights greater than 100 ft

Lines, surfaces, and arrises,
1/1,000 times the height
at any point but not more than 6 in.

Outside corner of exposed
corner columns and control
joint grooves in concrete,
1/2,000 times the height at
any point but not more than 3 in.

(2) Lateral alignment

Members 1 in.

In slabs, centerline location of
openings 12 in. or smaller
and edge location of larger openings 1/2 in.

Sawcuts, joints, and weakened
plane embedment in slabs 3/4 in.

(3) Level alignment

Top of slabs

Elevation of slabs-on-grade 3/4 in.

Elevation of top surfaces
of formed slabs before
removal of supporting shores 3/4 in.

Elevation of formed surfaces
before removal of shores 3/4 in.

Lintels, sills, parapets,
horizontal grooves, and other
lines exposed to view 1/2 in.

(4) Cross-sectional dimensions

Members, such as columns,
beams, piers, walls (thickness
only), and slabs (thickness only)

12-in. dimension or less +3/8 in.
..... -1/4 in.

More than 12 in. but not
over 3-ft dimension +1/2 in.
..... -3/8 in.

Over 3-ft dimension +1 in.
.....-3/4 in.

(5) Relative alignment

Stairs

Difference in height
between adjacent risers 1/8 in.

Difference in width
between adjacent treads 1/4 in.

Grooves

Specified width 2 in. or less 1/8 in.

Specified width more than
2 in. but not more than 12 in 1/4 in.

Sawcuts, joints, and weakened plane on slab

Lateral, gradual 3/4 in. in 10 ft

Lateral, abrupt 0 in.

(6) Openings through members

Cross-sectional size of opening -1/4 in.
..... +1 in.

Location of centerline of opening 1/2 in.

TOLERANCE FOR FINISHED FORMED CONCRETE SURFACES

(1) Vertical alignment

Formed surfaces slope with
respect to the specified plane

Vertical alignment of outside
corner of exposed corner
columns and control joint
grooves in concrete exposed
to view 1/4 in. in 10 ft

All other conditions 3/8 in. in 10 ft

(2) Abrupt variation

The offset between concrete surfaces for the following classes of surface:

Class B	1/4 in.
Class C	1/4 in.
Class D	1 in.

(3) Gradual variation

Surface finish tolerances as measured by placing a freestanding (unleveled), 5-ft straightedge for plane surface or curved template for curved surface anywhere on the surface and allowing it to rest upon two high spots within 72 hr after concrete placement. The gap at any point between the straightedge or template and the surface shall not exceed:

Class B	1/4 in.
Class C	1/2 in.
Class D	1 in.

TOLERANCES FOR CAST-IN-PLACE, VERTICALLY SLIPFORMED
BUILDING ELEMENTS

(1) Translation and rotation from a fixed point at the base of the structure:

For heights 100 ft or less 2 in.

For heights greater than 100 ft,
1/600 times the height
but not more than 8 in.

(2) Lateral alignment

Between adjacent elements 2 in.

(3) Cross-sectional dimensions

Wall thickness +3/4 in.
..... -3/8 in.

(4) Relative alignment

Formed surface slope with
respect to the specified plane 3/4 in. in 10 ft

TOLERANCES FOR TUNNEL LININGS, CONDUITS, AND FILLING
AND EMPTYING CULVERTS

(1) Lateral alignment

Centerline alignment

Water conveying tunnels,
conduits, and culverts 1/2 in.

Others 1 in.

Inside dimensions 0.005 times inside dimension

(2) Level alignment

Profile grade

Water conveying tunnels,
conduits, and culverts 1/2 in.

Others 1 in.

Surface of invert 1/4 in.

Surface of side slope 1/2 in.

(3) Cross-sectional dimension

Thickness at any point

Tunnel and culvert lining -0 in.

Conduits +5 percent thickness but
..... not less than 1/2 in.
..... -2.5 percent thickness but
..... not less than 1/4 in.

1.5.2 Tolerance for Floors by Straightedge Measurement

Floor finish tolerances shall be measured by placing a free-standing (unleveled) 10 foot straightedge anywhere on the slab and allowing it to rest upon two high spots. The measurements shall be taken within 72 hours after slab concrete placement. The gap at any point between the straightedge and the floor shall not exceed:

Floated surface ----- 1/2 inch
Flat surface ----- 3/16 inch

1.5.3 Appearance

Permanently exposed surfaces shall be cleaned, if stained or otherwise discolored, by a method that does not harm the concrete and that is approved by the Contracting Officer.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Cementitious Materials

Cementitious materials shall be portland cement, portland-pozzolan cement, portland blast-furnace slag cement, portland cement in combination with pozzolan or GGBF slag and shall conform to appropriate specifications listed below. Use of cementitious materials in architectural concrete shall be restricted to one color, one source, and one type.

2.1.1.1 Portland Cement

ASTM C 150, Type I or II, except that the maximum amount of C3A in Type I cement shall be 15 percent.

2.1.1.2 High-Early-Strength Portland Cement

ASTM C 150, Type III, used only when specifically approved in writing.

2.1.1.3 Pozzolan, Other than Silica Fume

Pozzolan shall conform to ASTM C 618, Class C, with the optional requirements for multiple factor, drying shrinkage, and uniformity of Table 2A. Table 1A requirement for maximum alkalies shall apply when used with aggregates listed at the end of this section to require low-alkali cement.

2.1.2 Aggregates

2.1.2.1 General

Concrete aggregates may be furnished from any source capable of meeting the quality requirements as stated in paragraph QUALITY. Fine and coarse aggregates shall conform to the grading requirements of ASTM C 33. The nominal maximum size shall be as listed in paragraph NOMINAL MAXIMUM-SIZE COARSE AGGREGATE.

2.1.2.2 Quality

Aggregates delivered to the mixer shall meet the requirements of ASTM C 33 for Severe Weathering Region Class 3S.

2.1.3 Chemical Admixtures

Chemical admixtures to be used, when required or permitted, shall conform to the appropriate specification listed.

2.1.3.1 Air-Entraining Admixture

The air-entraining admixture shall conform to ASTM C 260 and shall consistently cause the concrete to have an air content in the specified ranges under field conditions.

2.1.3.2 Accelerating Admixture

Accelerators shall meet the requirements of ASTM C 494, Type C or E, except that calcium chloride or admixtures containing calcium chloride shall not be used.

2.1.3.3 Water-Reducing or Retarding Admixtures

- a. Water-Reducing or Retarding Admixtures: ASTM C 494, Type A, B, or D, except that the 6-month and 1-year compressive strength tests are waived.
- b. High-Range Water Reducing Admixture: ASTM C 494, Type F or G except that the 6-month and 1-year strength requirements shall be waived. The admixture may be used only when approved by the Contracting Officer, such approval being contingent upon particular mixture control as described in the Contractor's Quality Control Plan.

2.1.3.4 Other Chemical Admixtures

Other chemical admixtures for use in producing flowing concrete shall comply with ASTM C 1017, Type 1 or 2. These admixtures shall be used only for concrete listed in paragraph SLUMP.

2.1.4 Curing Materials

2.1.4.1 Impervious-Sheet Curing Materials

Impervious-sheet curing materials shall conform to ASTM C 171, type optional, except polyethylene film shall not be used.

2.1.4.2 Membrane-Forming Curing Compound

The membrane-forming curing compound shall conform to ASTM C 309, Type 1-D or 2, except a styrene acrylate or chlorinated rubber compound meeting Class B requirements shall be used for surfaces that are to be painted or are to receive bituminous roofing, or waterproofing, or floors that are to receive adhesive applications of resilient flooring. The curing compound selected shall be compatible with any subsequent paint, roofing, coating, or flooring specified. Nonpigmented compound shall contain a fugitive dye and shall have the reflective requirements in ASTM C 309 waived.

2.1.4.3 Burlap

Burlap used for curing shall conform to COE CRD-C 318.

2.1.5 Water

Water for mixing and curing shall be fresh, clean, potable, and free of injurious amounts of oil, acid, salt, or alkali, except that nonpotable water may be used if it meets the requirements of COE CRD-C 400.

2.1.6 Nonshrink Grout

Nonshrink grout shall conform to ASTM C 1107 and shall be a commercial formulation suitable for the application proposed.

2.1.7 Abrasive Aggregates

Fifty-five percent, minimum, aluminum oxide or silicon-dioxide abrasive ceramically bonded together to form a homogeneous material sufficiently porous to provide a good bond with portland paste; or factory-graded emery aggregate consisting of not less than 45 percent aluminum oxide and 25 percent ferric oxide. The aggregate shall be well graded from particles retained on the 600- μ m (No. 30) sieve to particles passing the 2.36-mm (No. 8) sieve.

2.1.8 Latex Bonding Compound

Latex bonding compound agents for bonding fresh to hardened concrete shall conform to ASTM C 1059.

2.1.9 Epoxy Resin

Epoxy resins for use in repairs shall conform to ASTM C 881, Type III, Grade I or II.

2.2 CONCRETE MIXTURE PROPORTIONING

2.2.1 Quality of Mixture

For each portion of the structure, mixture proportions shall be selected so that the strength and W/C requirements listed in paragraph DESIGN REQUIREMENTS are met.

2.2.2 Nominal Maximum-Size Coarse Aggregate

Nominal maximum-size coarse aggregate shall be 1-1/2 inch except 3/4 inch nominal maximum-size coarse aggregate shall be used when any of the following conditions exist: the narrowest dimension between sides of forms is less than 7-1/2 inches, the depth of the slab is less than 4 inches, or the minimum clear spacing between reinforcing is less than 2-1/4 inches.

2.2.3 Air Content

Air content as delivered to the forms and as determined by ASTM C 231 shall be between 4 and 7 percent except that when the nominal maximum-size coarse aggregate is 3/4 inch, it shall be between 4-1/2 and 7-1/2 percent.

2.2.4 Slump

The slump shall be determined in accordance with ASTM C 143 and shall be within the range of 1 to 4 inches. Where placement by pump is approved, the slump shall not exceed 6 inches. Concrete to be placed in pump station substructure and superstructure may contain a chemical admixture for use in producing flowing concrete in accordance with ASTM C 1017, and the slump of the concrete shall not exceed 8 inches.

2.2.5 Concrete Proportioning

Trial batches and testing requirements for various qualities of concrete specified shall be the responsibility of the Contractor. Samples of aggregates shall be obtained in accordance with the requirements of ASTM D 75. Samples of materials other than aggregate shall be representative of those proposed for the project and shall be accompanied by the manufacturer's test reports indicating compliance with applicable specified requirements. Trial mixtures having proportions, consistencies, and air content suitable for the work shall be made based on methodology described in ACI 211.191, using at least three different water-cement ratios, which will produce a range of strength encompassing those required for the work. The maximum water-cement ratios required in paragraph MAXIMUM WATER-CEMENT RATIO will be converted to a weight ratio of water to cement plus pozzolan by mass, or GGBF slag by mass equivalency as described in ACI 211.191. If pozzolan is used in the concrete mixture, the maximum pozzolan content shall be 15 percent of the total cementitious material. Trial mixtures shall be proportioned for maximum permitted slump and air content with due consideration to the approved conveying and placement method. The temperature of concrete in each trial batch shall be reported. For each water-cement ratio, at least three test cylinders for each test age shall be made and cured in accordance with ASTM C 192. They shall be tested at 7 days and at the design age specified in paragraph DESIGN REQUIREMENTS in accordance with ASTM C 39. From these test results, a curve will be plotted showing the relationship between water-cement ratio and strength.

2.2.6 Required Average Compressive Strength

In meeting the strength requirements specified in paragraph CONCRETE STRENGTH, the selected mixture proportion shall produce a required average compressive strength f'_{cr} exceeding the specified strength f'_c by the amount indicated below.

2.2.6.1 Average Compressive Strength from Test Records

Where a concrete production facility has test records, a standard deviation shall be established in accordance with the applicable provisions of ACI 021.489. Test records from which a standard deviation is calculated shall represent materials, quality control procedures, and conditions similar to those expected, shall represent concrete produced to meet a specified strength or strengths (f'_c) within 1,000 psi of that specified for proposed work, and shall consist of at least 30 consecutive tests. A strength test shall be the average of the strengths of two cylinders made from the same sample of concrete and tested at 28 days or at another test age designated for determination of f'_c .

Required average compressive strength f'_{cr} used as the basis for selection of concrete proportions shall be the larger of the equations that follow using the standard deviation as determined above:

$$f'_{cr} = f'_c + 1.34S$$

$$f'_{cr} = f'_c + 2.33S - 500$$

Where S = standard deviation

Where a concrete production facility does not have test records meeting the requirements above but does have a record based on 15 to 29 consecutive tests, a standard deviation shall be established as the product of the calculated standard deviation and a modification factor from the following table:

NUMBER OF TESTS*	MODIFICATION FACTOR FOR STANDARD DEVIATION	
	Use tabulation in paragraph DETERMINING REQUIRED AVERAGE STRENGTH	
less than 15		
15		1.16
20		1.08
25		1.03
30 or more		1.00

*Interpolate for intermediate numbers of tests.

2.2.6.2 Average Compressive Strength without Previous Test Records

When a concrete production facility does not have sufficient field strength test records for calculation of the standard deviation, the required average strength f'_{cr} shall be determined as follows:

If the specified compressive strength f'_c is less than 3,000 psi,

$$f'_{cr} = f'_c + 1,000$$

If the specified compressive strength f'_c is 3,000 to 5,000 psi,

$$f'_{cr} = f'_c + 1,200$$

If the specified compressive strength f'_c is over 5,000 psi,

$$f'_{cr} = f'_c + 1,400$$

PART 3 EXECUTION

3.1 EQUIPMENT

3.1.1 Capacity

The batching, mixing, conveying, and placing equipment shall have a capacity of at least 200 cubic yards per hour.

3.1.2 Batch Plant

Batching plant or ready mix plant shall conform to the requirements of NRMCA CPMB 100 and as specified; however, rating plates attached to batch plant equipment are not required.

3.1.2.1 Batching Equipment

The batching controls shall be partially automatic, semiautomatic, or automatic. The semiautomatic batching system shall be provided with interlocks such that the discharge device cannot be actuated until the indicated material is within the applicable tolerance. The batching system shall be equipped with an accurate recorder or recorders that meet the requirements of NRMCA CPMB 100. Separate bins or compartments shall be provided for each size group of aggregate and cement, and pozzolan. Aggregates shall be weighed either in separate weigh batchers with individual scales or cumulatively in one weigh batcher on one scale. Aggregate shall not be weighed in the same batcher with cement, or pozzolan. If both cement and pozzolan are used, they may be batched cumulatively provided that the portland cement is batched first. If measured by mass, the mass of the water shall not be weighed cumulatively with another ingredient. Water batcher filling and discharging valves shall be so interlocked that the discharge valve cannot be opened before the filling valve is fully closed. An accurate mechanical device for measuring and dispensing each admixture shall be provided. Each dispenser shall be interlocked with the batching and discharging operation of the water so that each admixture is separately batched and discharged automatically in a manner to obtain uniform distribution throughout the batch in the specified mixing period. Admixtures shall not be combined prior to introduction in water. The plant shall be arranged so as to facilitate the inspection of all operations at all times. Suitable facilities shall be provided for obtaining representative samples of aggregates from each bin or compartment. All filling ports for cementitious materials bins or silos shall be clearly marked with a permanent sign stating the contents.

3.1.2.2 Scales

The equipment for batching by mass shall conform to the applicable requirements of NIST HB 44, except that the accuracy shall be plus or minus 0.2 percent of scale capacity. The Contractor shall provide standard test weights and any other auxiliary equipment required for checking the operating performance of each scale or other measuring devices. Tests shall be made at the frequency required in paragraph TESTS AND INSPECTIONS, and in the presence of a government inspector.

3.1.2.3 Batching Tolerances

a. Weighing Tolerances

MATERIAL	PERCENT OF REQUIRED MASS
Cementitious materials	0 to plus 2
Aggregate.....	plus or minus 2
Water.....	plus or minus 1
Chemical admixture.....	0 to plus 6

b. Volumetric Tolerances - For volumetric batching equipment, the following tolerances shall apply to the required volume of material being batched:

Water:	Plus or minus 1 percent.
Chemical admixtures:	Zero to plus 6 percent.

3.1.2.4 Moisture Control

The plant shall be capable of ready adjustment to compensate for the varying moisture content of the aggregates and to change the masses of the materials being batched. An electric moisture meter

complying with the provisions of COE CRD-C 143 shall be provided for measuring moisture in the fine aggregate. The sensing element shall be arranged so that the measurement is made near the batcher charging gate of the sand bin or in the sand batcher.

3.1.3 Concrete Mixers

The concrete mixers shall not be charged in excess of the capacity recommended by the manufacturer. The mixers shall be operated at the drum or mixing blade speed designated by the manufacturer. The mixers shall be maintained in satisfactory operating condition, and the mixer drums shall be kept free of hardened concrete. Should any mixer at any time produce unsatisfactory results, its use shall be promptly discontinued until it is repaired.

3.1.3.1 Stationary Mixers

Concrete plant mixers shall be tilting, nontilting, horizontal-shaft, vertical-shaft, or pugmill and shall be provided with an acceptable device to lock the discharge mechanism until the required mixing time has elapsed. The mixing time and uniformity shall conform to all the requirements in ASTM C 94 applicable to central-mixed concrete.

3.1.3.2 Truck Mixers

Truck mixers, the mixing of concrete therein, and concrete uniformity shall conform to the requirements of ASTM C 94. A truck mixer may be used either for complete mixing (transit-mixed) or to finish the partial mixing done in a stationary mixer (shrink-mixed). Each truck shall be equipped with two counters from which it will be possible to determine the number of revolutions at mixing speed and the number of revolutions at agitating speed.

3.1.4 Conveying Equipment

The conveying equipment shall conform to the following requirements.

3.1.4.1 Buckets

The interior hopper slope shall be not less than 58 degrees from the horizontal, the minimum dimension of the clear gate opening shall be at least five times the nominal maximum-size aggregate, and the area of the gate opening shall not be less than 2 square feet. The maximum dimension of the gate opening shall not be greater than twice the minimum dimension. The bucket gates shall be essentially grout tight when closed and may be manually, pneumatically, or hydraulically operated except that buckets larger than 2 cubic yards shall not be manually operated. The design of the bucket shall provide means for positive regulation of the amount and rate of deposit of concrete in each dumping position.

3.1.4.2 Transfer Hoppers

Concrete may be charged into nonagitating hoppers for transfer to other conveying devices. Transfer hoppers shall be capable of receiving concrete directly from delivery vehicles and have conical-shaped discharge features. The transfer hopper shall be equipped with a hydraulically operated gate and with a means of external vibration to effect complete discharge. Concrete shall not be held in nonagitating transfer hoppers more than 30 minutes.

3.1.4.3 Trucks

Truck mixers operating at agitating speed or truck agitators used for transporting plant-mixed concrete shall conform to the requirements of ASTM C 94. Nonagitating equipment may be used for transporting plant-mixed concrete over a smooth road when the hauling time is less than 15 minutes. Bodies of nonagitating equipment shall be smooth, watertight, metal containers specifically designed to transport concrete, shaped with rounded corners to minimize segregation, and equipped with gates that will permit positive control of the discharge of the concrete.

3.1.4.4 Chutes

When concrete can be placed directly from a truck mixer, agitator, or nonagitating equipment, the chutes attached to this equipment by the manufacturer may be used. A discharge deflector shall be used when required by the Contracting Officer. Separate chutes and other similar equipment will not be permitted for conveying concrete.

3.1.4.5 Belt Conveyors

Belt conveyors shall be designed and operated to assure a uniform flow of concrete from mixer to final place of deposit without segregation of ingredients or loss of mortar and shall be provided with positive means for preventing segregation of the concrete at the transfer points and the point of placing. Belt conveyors shall be constructed such that the idler spacing shall not exceed 36 inches. The belt speed shall be a minimum of 300 feet per minute and a maximum of 750 feet per minute. If concrete is to be placed through installed horizontal or sloping reinforcing bars, the conveyor shall discharge concrete into a pipe or elephant trunk that is long enough to extend through the reinforcing bars.

3.1.4.6 Concrete Pumps

Concrete may be conveyed by positive displacement pump when approved. The pumping equipment shall be piston or squeeze pressure. The pipeline shall be rigid steel pipe or heavy-duty flexible hose. The inside diameter of the pipe shall be at least three times the nominal maximum-size coarse aggregate in the concrete mixture to be pumped but not less than 4 inches. Aluminum pipe shall not be used.

3.1.5 Vibrators

Vibrators of the proper size, frequency, and amplitude shall be used for the type of work being performed in conformance with the following requirements:

APPLICATION	HEAD DIAMETER INCHES	FREQUENCY VPM	AMPLITUDE INCHES
Thin walls, beams, etc.	1-1/4 to 2-1/2	9,000 to 13,500	0.02 to 0.04
General construction	2 to 3-1/2	8,000 to 12,000	0.025 to 0.05

The frequency and amplitude shall be determined in accordance with COE CRD-C 521.

3.2 PREPARATION FOR PLACING

3.2.1 Embedded Items

Before placement of concrete, care shall be taken to determine that all embedded items are firmly and securely fastened in place as indicated on the drawings, or required. Embedded items shall be free of oil and other foreign matter such as loose coatings or rust, paint, and scale. The embedding of wood in concrete will be permitted only when specifically authorized or directed. Voids in sleeves, inserts, and anchor slots shall be filled temporarily with readily removable materials to prevent the entry of concrete into voids. Welding, including tack welding, will not be permitted on embedded metals within 2 feet of the surface of the concrete.

3.2.2 Concrete on Earth Foundations

Earth surfaces upon which concrete is to be placed shall be clean, damp, and free from debris, frost, ice, and standing or running water. Prior to placement of concrete, the earth foundation shall have been satisfactorily compacted in accordance with Section 02221 EXCAVATION, FILL, BACKFILL AND EMBANKMENT FOR STRUCTURES.

3.2.3 Construction Joint Treatment

Construction joint treatment where shown on drawings shall conform to the following requirements.

3.2.3.1 Joint Preparation

Concrete surfaces to which additional concrete is to be bonded shall be prepared for receiving the next lift or adjacent concrete by cleaning with either air-water cutting, sandblasting, high-pressure water jet, or other approved method. Air-water cutting will not be permitted on formed surfaces or surfaces congested with reinforcing steel. Regardless of the method used, the resulting surfaces shall be free from all laitance and inferior concrete so that clean, well bonded coarse aggregate is exposed uniformly throughout the lift surface. The edges of the coarse aggregate shall not be undercut. The surface shall be washed clean again as the last operation prior to placing the next lift. There shall be no standing water on the surface upon which concrete is placed.

3.2.3.2 Air-Water Cutting

Air-water cutting of a construction joint shall be performed at the proper time and only on horizontal construction joints. The air pressure used in the jet shall be 90 to 110 psi, and the water pressure shall be just sufficient to bring the water into effective influence of the air pressure. When approved by the Contracting Officer, a retarder complying with the requirements of COE CRD-C 94 may be applied to the surface of the lift to prolong the period of time during which air-water cutting is effective. Prior to receiving approval, the Contractor shall furnish samples of the material to be used and shall demonstrate the method to be used in applications. After cutting, the surface shall be washed and rinsed as long as there is any trace of cloudiness of the wash water. Where necessary to remove accumulated laitance, coatings, stains, debris, and other foreign material, high-pressure water jet or sandblasting will be required as the last operation before placing the next lift.

3.2.3.3 High-Pressure Water Jet

A stream of water under a pressure of not less than 3,000 psi may be used for cleaning. Its use shall be delayed until the concrete is sufficiently hard so that only the surface skin or mortar is removed and

there is no undercutting of coarse-aggregate particles. If the water jet is incapable of a satisfactory cleaning, the surface shall be cleaned by sandblasting.

3.2.3.4 Wet Sandblasting

This method may be used when the concrete has reached sufficient strength to prevent undercutting of the coarse aggregate particles. The surface of the concrete shall then be washed thoroughly to remove all loose materials.

3.2.3.5 Waste Disposal

The method used in disposing of waste water employed in cutting, washing, and rinsing of concrete surfaces shall be such that the waste water does not stain, discolor, or affect exposed surfaces of the structures, or damage the environment of the project area. The method of disposal shall be subject to approval.

3.3 PLACING

3.3.1 Placing Procedures

The surfaces of horizontal construction joints shall be kept continuously wet for the first 12 hours during the 24-hour period prior to placing concrete. Surfaces may be dampened immediately before placement if necessary. Concrete placement will not be permitted when, in the opinion of the Contracting Officer, weather conditions prevent proper placement and consolidation. Concrete shall be deposited as close as possible to its final position in the forms and, in so depositing, there shall be no vertical drop greater than 5 feet except where suitable equipment is provided to prevent segregation and where specifically authorized. Depositing of the concrete shall be so regulated that it may be effectively consolidated in horizontal layers 2.0 feet or less in thickness with a minimum of lateral movement. The amount deposited in each location shall be that which can be readily and thoroughly consolidated. Sufficient placing capacity shall be provided so that concrete placement can be kept plastic and free of cold joints while concrete is being placed. Concrete shall be placed by methods that will prevent segregation or loss of ingredients. Any concrete transferred from one conveying device to another shall be passed through a hopper that is conical in shape. The concrete shall not be dropped vertically more than 5 feet, except where a properly designed and sized elephant truck with rigid drop chute bottom section is provided to prevent segregation and where specifically authorized. In no case will concrete be discharged to free-fall through reinforcing bars.

3.3.2 Placement by Pump

When concrete is to be placed by pump, the nominal maximum-size coarse aggregate shall not be reduced to accommodate the pumps. The distance to be pumped shall not exceed limits recommended by the pump manufacturer. The concrete shall be supplied to the concrete pump continuously. When pumping is completed, concrete remaining in the pipeline shall be ejected without contamination of concrete in place. After each operation, equipment shall be thoroughly cleaned, and flushing water shall be wasted outside of the forms. Grout used to lubricate the pumping equipment at the beginning of the placement will not be incorporated into the placement.

3.3.3 Time Interval Between Mixing and Placing

Concrete shall be placed within 30 minutes after discharge into nonagitating equipment. When concrete is truck-mixed or when a truck mixer or agitator is used for transporting concrete mixed by a

concrete plant mixer, the concrete shall be delivered to the site of the work, and discharge shall be completed within 1-1/2 hours after introduction of the cement to the aggregates. When the length of haul makes it impossible to deliver truck-mixed concrete within these time limits, batching of cement and a portion of the mixing water shall be delayed until the truck mixer is at or near the construction site.

3.3.4 Cold-Weather Placing

When cold-weather placing of concrete is likely to be subjected to freezing temperatures before the expiration of the curing period, it shall be placed in accordance with procedures previously submitted in accordance with paragraph SUBMITTALS. The ambient temperature of the space adjacent to the concrete placement and surfaces to receive concrete shall be above 32 degrees F. The placing temperature of the concrete having a minimum dimension less than 12 inches shall be between 55 and 75 degrees F when measured in accordance with ASTM C 1064. The placing temperature of the concrete having a minimum dimension greater than 12 inches shall be between 50 and 70 degrees F. Heating of the mixing water or aggregates will be required to regulate the concrete-placing temperatures. Materials entering the mixer shall be free from ice, snow, or frozen lumps. Salt, chemicals, or other materials shall not be mixed with the concrete to prevent freezing.

3.3.5 Hot-Weather Placing

Concrete shall be properly placed and finished with procedures previously submitted in accordance with paragraph SUBMITTALS. The concrete-placing temperature shall not exceed 90 degrees F when measured in accordance with ASTM C 1064. Cooling of the mixing water and aggregates, or both, may be required to obtain an adequate placing temperature. A retarder meeting the requirements of paragraph WATER-REDUCING OR RETARDING ADMIXTURES may be used to facilitate placing and finishing. Steel forms and reinforcement shall be cooled prior to concrete placement when steel temperatures are greater than 120 degrees F. Conveying and placing equipment shall be cooled if necessary to maintain proper concrete-placing temperature.

3.3.6 Consolidation

Immediately after placement, each layer of concrete, including flowing concrete, shall be consolidated by internal vibrating equipment. Vibrators shall not be used to transport concrete within the forms. Hand spading may be required, if necessary, with internal vibrating along formed surfaces permanently exposed to view. Form or surface vibrators shall not be used unless specifically approved. The vibrator shall be inserted vertically at uniform spacing over the entire area of placement. The distance between insertions shall be approximately 1-1/2 times the radius of action of the vibrator. The vibrator shall penetrate rapidly to the bottom of the layer and at least 6 inches into the preceding unhardened layer if such exists. It shall be held stationary until the concrete is consolidated and then withdrawn slowly.

3.4 FINISHING

The ambient temperature of spaces adjacent to surfaces being finished shall be not less than 40 degrees F. In hot weather when the rate of evaporation of surface moisture, as determined by use of Figure 2.1.5 of ACI 030591, may reasonably be expected to exceed 0.2 pounds per square foot per hour. Provisions for windbreaks, shading, fog spraying, or wet covering with a light-colored material shall be made in advance of placement, and such protective measures shall be taken as quickly as finishing operations will allow. All unformed surfaces that are not to be covered by additional concrete or backfill shall have a float finish. Additional finishing shall be as specified below and shall be true to

the elevation shown in the drawings. Surfaces to receive additional concrete or backfill shall be brought to the elevation shown on the drawings and left true and regular. Exterior surfaces shall be sloped for drainage unless otherwise shown in the drawing or as directed. Joints shall be carefully made with a jointing or edging tool. The finished surfaces shall be protected from stains or abrasions. Grate tampers or jitterbugs shall not be used.

3.4.1 Unformed Surfaces

3.4.1.1 Float Finish

Surfaces shall be screeded and darried or bullfloated to bring the surface to the required finish level with no coarse aggregate visible. No water, cement, or mortar shall be added to the surface during the finishing operation. The concrete, while still green but sufficiently hardened to bear a man's weight without deep imprint, shall be floated to a true and even plane. Floating may be performed by use of suitable hand floats or power-driven equipment. Hand floats shall be made of magnesium or aluminum.

3.4.1.2 Trowel Finish

A trowel finish shall be applied to the following surfaces: a. all interior floor slabs, b. top surface of conduit slabs and water passageways. Concrete surfaces shall be finished with a float finish, and after surface moisture has disappeared, the surface shall be troweled to a smooth, even, dense finish free from blemishes including trowel marks.

3.4.1.3 Abrasive Aggregate Finish

An abrasive aggregate finish shall be applied to the following surfaces: concrete stair treads and landings. The concrete surface shall be finished with a float finish. Abrasive aggregate shall be uniformly sprinkled over the floated surface at a rate of not less than 1/4 pounds per square foot. The surface shall be troweled to a smooth, even finish that is uniform in texture and appearance and free from blemishes including trowels marks. Immediately after curing, cement coating or laitance covering the abrasive aggregate shall be removed by steel brushing, rubbing with abrasive stone, or sandblasting to expose the abrasive particles.

3.4.1.4 Broom Finish

A broom finish shall be applied to the following surfaces: (a) exterior slabs, sidewalks and drives (b) top slab surface at levels 292 & 312 (c) top of gate tower. The concrete surface shall be finished with a float finish. The floated surface shall be broomed with a fiber-bristle brush in a direction transverse to that of the main traffic.

3.4.2 Formed Surfaces

Unless another finish is specified, surfaces shall be left with the texture imparted by the forms except that defective surfaces shall be repaired as described in paragraph FORMED SURFACE REPAIR. Other finishes shall be applied to the following structures or portions of structures:

TYPES OF FINISH	STRUCTURE OR PORTION OF STRUCTURE
Grout-cleaned (rubbed)	Exposed surfaces above elevation 292 and as noted as rubbed

Unless painting of surfaces is required, uniform color of the concrete shall be maintained by use of only one mixture without changes in materials or proportions for any structure or portion of structure that is exposed to view or on which a special finish is required. The form panels used to produce the finish shall be orderly in arrangement, with joints between panels planned in approved relation to openings, building corners, and other architectural features.

3.4.2.1 Grout-Cleaned Finish

The surfaces of all above ground exposed surfaces except water conduits and as shown on drawings shall be given a grout-cleaned finish as described, as approved by the Contracting Officer and after all required curing, cleaning, and repairs have been completed. Surfaces to be grout-cleaned shall be moist cured for the required period of time before application of the grout-cleaned finish. Grout-cleaning shall be delayed until near the end of construction on all surfaces not to be painted in order to achieve uniformity of appearance and reduce the chance of discoloring caused by subsequent construction operations. The temperature of the air adjacent to the surface shall be not less than 40 degrees F for 24 hours prior to and 72 hours following the application of the finish. The finish for any area shall be completed in the same day, and the limits of a finished area shall be made at natural breaks in the finished surface. The surface to receive grout-cleaned finish shall be thoroughly wetted to prevent absorption of water from the grout but shall have no free water present. The surface shall then be coated with grout. The grout shall be applied as soon as the surface of the concrete approaches surface dryness and shall be vigorously and thoroughly rubbed over the area with clean burlap pads, cork floats or stones, so as to fill all voids. The grout shall be composed of one part portland cement as used on the project, to two parts by volume of well-graded sand passing a 600- μ m (No. 30) sieve mixed with water to the consistency of thick paint. White portland cement shall be used for all or part of the cement as approved by the Contracting Officer to give the desired finish color. The applied coating shall be uniform, completely filling all pits, air bubbles, and surface voids. While the grout is still plastic, remove all excess grout by working the surface with a rubber float, burlap pad, or other means. Then, after the surface whitens from drying (about 30 minutes at normal temperature) rub vigorously with clean burlap pads. Immediately after rubbing is completed, the finished surface shall be continuously moist cured for 72 hours. Burlap pads used for this operation shall be burlap stretched tightly around a board to prevent dishing the mortar in the voids.

3.4.3 Formed Surface Repair

After removal of forms, all ridges, lips, and bulges on surfaces permanently exposed shall be removed. All repairs shall be completed within 48 hours after form removal.

3.4.3.1 Class B Finishes

Surfaces listed in Section 03101 FORMWORK FOR CONCRETE and as shown to have class B finishes shall have surface defects repaired as follows: defective areas, voids, and honeycombs smaller than 16 square inches in area and less than 1/2 inch deep and bug holes exceeding 1/2 inch in diameter shall be chipped and filled with dry-packed mortar. Holes left by removal of tie rods shall be reamed and filled with dry-packed mortar as specified in paragraph MATERIAL AND PROCEDURE FOR

REPAIRS. Defective and unsound concrete areas larger than described shall be defined by 1/2 inch deep dovetailed saw cuts in a rectangular pattern with lines parallel to the formwork, the defective concrete removed by chipping, and the void repaired with replacement concrete. The prepared area shall be brush-coated with an epoxy resin meeting the requirements of paragraph EPOXY RESIN, a latex bonding agent meeting the requirements of paragraph LATEX BONDING COMPOUND, or a neat cement grout after dampening the area with water. The void shall be filled with replacement concrete in accordance with paragraph MATERIAL AND PROCEDURE FOR REPAIRS.

3.4.3.2 Class C Finish

Surfaces listed in Section 03101 FORMWORK FOR CONCRETE and as shown shall have defects repaired as follows: defective areas, voids, and honeycombs smaller than 24 square inches and less than 2 inches deep; bug holes exceeding 1-1/2 inches in diameter shall be chipped and filled with dry-packed mortar; and holes left by removal of the tie rods shall be chipped and filled with dry-packed mortar. Defective and unsound concrete areas larger than 24 square inches and deeper than 1-1/2 inches shall be defined by 1/2 inch deep dovetailed saw cuts in a rectangular pattern, the defective concrete removed by chipping, and the void repaired with replacement concrete. The prepared area shall be brush-coated with an epoxy resin meeting the requirements of paragraph EPOXY RESIN, a latex bonding agent meeting the requirements of paragraph LATEX BONDING COMPOUND, or a neat cement grout after dampening the area with water. The void shall be filled with replacement concrete in accordance with paragraph MATERIAL AND PROCEDURE FOR REPAIRS.

3.4.3.3 Class D Finish

Surfaces listed in Section 03101 FORMWORK FOR CONCRETE and as shown to have class D finish shall have surface defects repaired as follows: defective areas, voids, and honeycombs greater than 48 square inches in area or more than 2 inches deep shall be defined by 1/2 inch deep dovetailed saw cuts in a rectangular pattern, the defective concrete removed by chipping and the void repaired with replacement concrete. The prepared area shall be brush-coated with an epoxy resin meeting the requirements of paragraph EPOXY RESIN, a latex bonding agent meeting the requirements of paragraph LATEX BONDING COMPOUND, or a neat cement grout after dampening the area with water. The void shall be filled with replacement concrete in accordance with paragraph MATERIAL AND PROCEDURE FOR REPAIRS.

3.4.3.4 Material and Procedure for Repairs

The cement used in the dry-packed mortar or replacement concrete shall be a blend of the cement used for production of project concrete and white portland cement properly proportioned so that the final color of the mortar or concrete will match adjacent concrete. Trial batches shall be used to determine the proportions required to match colors. Dry-packed mortar shall consist of one part cement to two and one-half parts fine aggregate. The fine aggregate shall be that used for production of project concrete. The mortar shall be remixed over a period of at least 30 minutes without addition of water until it obtains the stiffest consistency that will permit placing. Mortar shall be thoroughly compacted into the prepared void by tamping, rodding, ramming, etc. and struck off to match adjacent concrete. Replacement concrete shall be produced using project materials and shall be proportioned by the Contracting Officer. It shall be thoroughly compacted into the prepared void by internal vibration, tamping, rodding, ramming, etc. and shall be struck off and finished to match adjacent concrete. Forms shall be used to confine the concrete. If an expanding agent is used in the repair concrete, the repair shall be thoroughly confined on all sides including the top surface. Metal tools shall not be used to finish permanently exposed surfaces. The repaired areas shall be cured for 7 days. The temperature of the in situ concrete, adjacent air, and replacement mortar or concrete shall be above 40 degrees F

during placement, finishing, and curing. Other methods and materials for repair may be used only when approved in writing by the Contracting Officer. Repairs of the so called "plaster-type" will not be permitted.

3.5 CURING AND PROTECTION

3.5.1 Duration

The length of the curing period shall be determined by the type of cementitious material, as specified below. Concrete shall be cured by an approved method.

Type I portland cement 7 days

Type II portland cement 14 days

Portland cement blended with

25 percent or less fly-ash or GGBF slag 14 days

Immediately after placement, concrete shall be protected from premature drying, extremes in temperatures, rapid temperature change, and mechanical damage. All materials and equipment needed for adequate curing and protection shall be available and at the placement site prior to the start of concrete placement. Concrete shall be protected from the damaging effects of rain for 12 hours and from flowing water for 14 days. No fire or excessive heat including welding shall be permitted near or in direct contact with concrete or concrete embedments at any time.

3.5.2 Moist Curing

Moist-cured concrete shall be maintained continuously, not periodically, wet for the entire curing period. If water or curing materials stain or discolor concrete surfaces that are to be permanently exposed, they shall be cleaned as required in paragraph APPEARANCE. Where wooden form sheathing is left in place during curing, the sheathing shall be kept wet at all times. Where steel forms are left in place during curing, the forms shall be carefully broken loose from the hardened concrete and curing water continuously applied into the void so as to continuously saturate the entire concrete surface. Horizontal surfaces may be moist cured by ponding, by covering with a minimum uniform thickness of 2 inches of continuously saturated sand, or by covering with saturated nonstaining burlap or cotton mats. Horizontal construction joints may be allowed to dry for 12 hours immediately prior to the placing of the following lift.

3.5.3 Membrane-Forming Curing Compound

Concrete may be cured with an approved membrane-forming curing compound in lieu of moist curing except that membrane curing will not be permitted on any surface to which a grout-cleaned finish is to be applied or other concrete is to be bonded, on any surface containing protruding steel reinforcement, on an abrasive aggregate finish, or any surface maintained at curing temperature by use of free steam. A styrene acrylate or chlorinated rubber compound may be used for surfaces that are to be painted or are to receive bituminous roofing or waterproofing, or for floors that are to receive adhesive applications of resilient flooring. The curing compound selected shall be compatible with any subsequent paint, roofing, waterproofing, or flooring specified.

3.5.3.1 Pigmented Curing Compound

A pigmented curing compound meeting the requirements of the above paragraph MEMBRANE-FORMING CURING COMPOUND may be used on surfaces that will not be exposed to view when the project is completed.

3.5.3.2 Nonpigmented Curing Compound

A nonpigmented curing compound containing a fugitive dye may be used on surfaces that will be exposed to view when the project is completed. Concrete cured with nonpigmented curing compound must be shaded from the sun for the first 3 days when the ambient temperature is 90 degrees F or higher.

3.5.3.3 Application

The curing compound shall be applied to formed surfaces immediately after the forms are removed and prior to any patching or other surface treatment except the cleaning of loose sand, mortar, and debris from the surface. The surfaces shall be thoroughly moistened with water, and the curing compound applied as soon as free water disappears. The curing compound shall be applied to unformed surfaces as soon as free water has disappeared and bleeding has stopped. The curing compound shall be applied in a two-coat continuous operation by approved motorized power-spraying equipment operating at a minimum pressure of 75 psi, at a uniform coverage of not more than 400 square feet per gallon for each coat, and the second coat shall be applied perpendicular to the first coat. Concrete surfaces that have been subjected to rainfall within 3 hours after curing compound has been applied shall be resprayed by the method and at the coverage specified. All concrete surfaces on which the curing compound has been applied shall be adequately protected for the duration of the entire curing period from pedestrian and vehicular traffic and from any other cause that will disrupt the continuity of the curing membrane.

3.5.4 Evaporation Retardant

The following concrete surfaces may be cured using sheet material:

All horizontal surfaces.

Sheet curing shall not be used on vertical or near-vertical surfaces. All surfaces shall be thoroughly wetted and be completely covered with waterproof paper or polyethylene-coated burlap having the burlap thoroughly water-saturated before placing. Covering shall be laid with light-colored side up. Covering shall be lapped not less than 12 inches and securely weighted down or shall be lapped not less than 4 inches and taped to form a continuous cover with completely closed joints. The sheet shall be weighted to prevent displacement so that it remains in contact with the concrete during the specified length of curing. Coverings shall be folded down over exposed edges of slabs and secured by approved means. Sheets shall be immediately repaired or replaced if tears or holes appear during the curing period.

3.5.5 Cold-Weather Curing and Protection

When the daily outdoor low temperature is less than 32 degrees F, the temperature of the concrete shall be maintained above 40 degrees F for the first 7 days after placing. In addition, during the period of protection removal, the air temperature adjacent to the concrete surfaces shall be controlled so that concrete near the surface will not be subjected to a temperature differential of more than 25 degrees F as determined by observation of ambient and concrete temperatures indicated by suitable temperatures

measuring devices furnished by the Government as required and installed adjacent to the concrete surface and 2 inches inside the surface of the concrete. The installation of the thermometers shall be made by the Contractor at such locations as may be directed.

3.6 SETTING OF BASE PLATES AND BEARING PLATES

3.6.1 Setting of Plates

After being plumbed and properly positioned, column base plates, bearing plates for beams and similar structural members, and machinery and equipment base plates shall be provided with full bearing with nonshrink grout. The space between the top of concrete or masonry-bearing surface and the bottom of the plate shall be approximately 1/24 of the width of the plate, but not less than 1/2 inch for plates less than 12 inches wide. Concrete surfaces shall be rough, clean, and free of oil, grease, and laitance, and they shall be damp. Metal surfaces shall be clean and free of oil, grease, and rust.

3.6.2 Nonshrink Grout Application

Nonshrink grout shall conform to the requirements of paragraph NONSHRINK GROUT. Water content shall be the minimum that will provide a flowable mixture and fill the space to be grouted without segregation, bleeding, or reduction of strength.

3.6.2.1 Mixing and Placing of Nonshrink Grout

Mixing and placing shall be in conformance with the material manufacturer's instructions and as specified. Ingredients shall be thoroughly dry-mixed before adding water. After adding water, the batch shall be mixed for 3 minutes. Batches shall be of size to allow continuous placement of freshly mixed grout. Grout not used within 30 minutes after mixing shall be discarded. The space between the top of the concrete or masonry-bearing surface and the plate shall be filled solid with the grout. Forms shall be of wood or other equally suitable material for retaining the grout and shall be removed after the grout has set. If grade "A" grout as specified in ASTM C 1107 is used, all surfaces shall be formed to provide restraint. The placed grout shall be worked to eliminate voids; however, overworking and breakdown of the initial set shall be avoided. Grout shall not be retempered or subjected to vibration from any source. Where clearances are unusually small, placement shall be under pressure with a grout pump. Temperature of the grout, and of surfaces receiving the grout, shall be maintained at 65 to 85 degrees F until after setting.

3.6.2.2 Treatment of Exposed Surfaces

After the grout has set, those types containing metallic aggregate shall have the exposed surfaces cut back 1 inch and immediately covered with a parge coat of mortar proportioned by mass of one part portland cement, two parts sand, and sufficient water to make the mixture placeable. The parge coat shall have a smooth, dense finish. The exposed surface of other types of nonshrink grout shall have a smooth, dense finish.

3.6.2.3 Curing

Grout and parge coats shall be cured in conformance with paragraph CURING AND PROTECTION.

3.7 TESTS AND INSPECTIONS

Tests and inspections shall conform to the following requirements.

3.7.1 General

The Contractor shall perform the inspections and tests described below, and, based upon the results of these inspections and tests, he shall take the action required and submit reports as required. When, in the opinion of the Contracting Officer, the concreting operation is out of control, concrete placement shall cease. The laboratory performing the tests shall be on-site and shall conform with ASTM C 1077. The individuals who sample and test concrete or the constituents of concrete as required in this specification shall have demonstrated a knowledge and ability to perform the necessary test procedures equivalent to the ACI minimum guidelines for certification of Concrete Field Testing Technicians, Grade I. The individuals who perform the inspection of concrete construction shall have demonstrated a knowledge and ability equivalent to the ACI minimum guidelines for certification of Concrete Construction Inspector, Level II. The Government will inspect the laboratory, equipment, and test procedures prior to start of concreting operations and at least once per year thereafter for conformance with ASTM C 1077.

3.7.2 Testing and Inspection Requirements

3.7.2.1 Fine Aggregate

- a. Grading - At least once during each shift when the concrete plant is operating, there shall be one sieve analysis and fineness modulus determination in accordance with ASTM C 136 and COE CRD-C 104 for the fine aggregate or for each size range of fine aggregate if it is batched in more than one size or classification. The location at which samples are taken may be selected by the Contractor as the most advantageous for control. However, the Contractor is responsible for delivering fine aggregate to the mixer within specification limits.
- b. Corrective Action for Fine Aggregate Grading - When the amount passing on any sieve is outside the specification limits, the fine aggregate shall be immediately resampled and retested. If there is another failure on any sieve, the fact shall immediately be reported to the Contracting Officer.
- c. Moisture Content Testing - When in the opinion of the Contracting Officer the electric moisture meter is not operating satisfactorily, there shall be at least four tests for moisture content in accordance with ASTM C 566 during each 8-hour period of mixing plant operation. The times for the tests shall be selected randomly within the 8-hour period. An additional test shall be made whenever the slump is shown to be out of control or excessive variation in workability is reported by the placing foreman. When the electric moisture meter is operating satisfactorily, at least two direct measurements of moisture content shall be made per week to check the calibration of the meter. The results of tests for moisture content shall be used to adjust the added water in the control of the batch plant.
- d. Moisture Content Corrective Action - Whenever the moisture content of the fine aggregate changes by 0.5 percent or more, the scale settings for the fine-aggregate batcher and water batcher shall be adjusted (directly or by means of a moisture compensation device) if necessary to maintain the specified slump.

3.7.2.2 Coarse Aggregate

- a. Grading - At least once during each shift in which the concrete plant is operating, there shall be a sieve analysis in accordance with ASTM C 136 for each size of coarse aggregate. The location at which samples are taken may be selected by the Contractor as the most advantageous for production control. However, the Contractor shall be responsible for delivering the aggregate to the mixer within specification limits. A test record of samples of aggregate taken at the same locations shall show the results of the current test as well as the average results of the five most recent tests including the current test. The Contractor may adopt limits for control which are coarser than the specification limits for samples taken at locations other than as delivered to the mixer to allow for degradation during handling.
- b. Corrective Action for Grading - When the amount passing any sieve is outside the specification limits, the coarse aggregate shall be immediately resampled and retested. If the second sample fails on any sieve, that fact shall be reported to the Contracting Officer. Where two consecutive averages of five tests are outside specification limits, the operation shall be considered out of control and shall be reported to the Contracting Officer. Concreting shall be stopped and immediate steps shall be taken to correct the grading.
- c. Coarse Aggregate Moisture Content - A test for moisture content of each size group of coarse aggregate shall be made at least twice per week. When two consecutive readings for smallest size coarse aggregate differ by more than 1.0 percent, frequency of testing shall be increased to that specified above for fine aggregate, until the difference falls below 1.0 percent.
- d. Coarse Aggregate Moisture Corrective Action - Whenever the moisture content of any size of coarse aggregate changes by 0.5 percent or more, the scale setting for the coarse aggregate batcher and the water batcher shall be adjusted if necessary to maintain the specified slump.

3.7.2.3 Quality of Aggregates

- a. Frequency of Quality Tests - Thirty days prior to the start of concrete placement the Contractor shall perform all tests for aggregate quality listed below. In addition, after the start of concrete placement, the Contractor shall perform tests for aggregate quality in accordance with the frequency schedule shown below. Samples tested after the start of concrete placement shall be taken immediately prior to entering the concrete mixer.

PROPERTY	FREQUENCY FINE AGGREGATE	FREQUENCY COARSE AGGREGATE	TEST
Specific Gravity	Every 3 months	Every 3 months	ASTM C 127 ASTM C 128
Absorption	Every 3 months	Every 3 months	ASTM C 127 ASTM C 128
Durability Factor Using,			COE CRD-C 114

(Procedure A)	Every 12 months	Every 12 months	ASTM C 666
Clay Lumps and Friable Particles	Every 3 months	Every 3 months	ASTM C 142
Material Finer than the 75-µm (No. 200) Sieve	Not applicable	Every 3 months	ASTM C 117
Impurities	Every 3 months	Not applicable	ASTM C 40 ASTM C 87
A.L. Abrasion	Not applicable	Every 6 months	ASTM C 131 ASTM C 535
Soft and Friable (Scratch Hardness)	Not applicable	Every 6 months	COE CRD-C 130
Petrographic Examination	Every 6 months	Every 6 months	ASTM C 295
Chert, less than 2.40 specific gravity	Every 6 months	Every 6 months	ASTM C 123
Coal and Lignite, less than 2.00 gravity	Every 6 months	Every 6 months	ASTM C 123

- b. Corrective Action for Aggregate Quality - If the result of a quality test fails to meet the requirements for quality immediately prior to start of concrete placement, production procedures or materials shall be changed and additional tests shall be performed until the material meets the quality requirements prior to proceeding with either mixture proportioning studies or starting concrete placement. After concrete placement commences, whenever the result of a test for quality fails the requirements, the test shall be rerun immediately. If the second test fails the quality requirement, the fact shall be reported to the Contracting Officer and immediate steps taken to rectify the situation.

3.7.2.4 Scales

- a. Weighing Accuracy - The accuracy of the scales shall be checked by test weights prior to start of concrete operations and at least once every 3 months for conformance with the applicable requirements of paragraph BATCHING EQUIPMENT. Such tests shall also be made as directed whenever there are variations in properties of the fresh concrete that could result from batching errors.

- b. Batching and Recording Accuracy - Once a week the accuracy of each batching and recording device shall be checked during a weighing operation by noting and recording the required weight, recorded weight, and the actual weight batched. The Contractor shall confirm that the calibration devices described in paragraph BATCH PLANT for checking the accuracy of dispensed admixtures are operating properly.
- c. Scales Corrective Action - When either the weighing accuracy or batching accuracy does not comply with specification requirements, the plant shall not be operated until necessary adjustments or repairs have been made. Discrepancies in recording accuracies shall be corrected immediately.

3.7.2.5 Batch-Plant Control

The measurement of all constituent materials including cementitious materials, each size of aggregate, water, and admixtures shall be continuously controlled. The aggregate weights and amount of added water shall be adjusted as necessary to compensate for free moisture in the aggregates. The amount of air-entraining agent shall be adjusted to control air content within specified limits. A report shall be prepared indicating type and source of cement used, type and source of pozzolan or slag used, amount and source of admixtures used, aggregate source, the required aggregate and water weights per cubic yard, amount of water as free moisture in each size of aggregate, and the batch aggregate and water weights per cubic yard for each class of concrete batched during plant operation.

3.7.2.6 Concrete Mixture

- a. Air Content Testing - Air content tests shall be made when test specimens are fabricated. In addition, at least two tests for air content shall be made on randomly selected batches of each separate concrete mixture produced during each 8-hour period of concrete production. Additional tests shall be made when excessive variation in workability is reported by the placing foreman or Government quality assurance representative. Tests shall be made in accordance with ASTM C 231. Test results shall be plotted on control charts which shall at all times be readily available to the Government. Copies of the current control charts shall be kept in the field by the Contractor's quality control representatives and results plotted as tests are made. When a single test result reaches either the upper or lower action limit a second test shall immediately be made. The results of the two tests shall be averaged and this average used as the air content of the batch to plot on both the control chart for air content and the control chart for range, and for determining the need for any remedial action. The result of each test, or average as noted in the previous sentence, shall be plotted on a separate chart for each mixture on which an "average line" is set at the midpoint of the specified air content range from paragraph AIR CONTENT. An upper warning limit and a lower warning limit line shall be set 1.0 percentage point above and below the average line. An upper action limit and a lower action limit line shall be set 1.5 percentage points above and below the average line, respectively. The range between each two consecutive tests shall be plotted on a control chart for range where an upper warning limit is set at 2.0 percentage points and up upper action limit is set at 3.0 percentage points. Samples for air content may be taken at the mixer, however, the Contractor is responsible for delivering the concrete to the placement site at the stipulated air content. If the Contractor's materials or transportation methods cause air content loss between the mixer and the placement, correlation samples shall be taken at the placement site as required by the Contracting Officer and the air content at the mixer controlled as directed.

- b. Air Content Corrective Action - Whenever points on the control chart for percent air reach either warning limit, an adjustment shall immediately be made in the amount of air-entraining admixture batched. As soon as is practical after each adjustment, another test shall be made to verify the result of the adjustment. Whenever a point on the control chart range reaches the warning limit, the admixture dispenser shall be recalibrated to ensure that it is operating accurately and with good reproducibility. Whenever a point on either control chart reaches an action limit line, the air content shall be considered out of control and the concreting operation shall immediately be halted until the air content is under control. Additional air content tests shall be made when concreting is restarted. All this shall be at no extra cost to the Government.
- c. Slump Testing - In addition to slump tests which shall be made when test specimens are fabricated, at least four slump tests shall be made on randomly selected batches in accordance with ASTM C 143 for each separate concrete mixture produced during each 8-hour or less period of concrete production each day. Also, additional tests shall be made when excessive variation in workability is reported by the placing foreman or Government's quality assurance representative. Test results shall be plotted on control charts which shall at all times be readily available to the Government. Copies of the current control charts shall be kept in the field by the Contractor's quality control representatives and results plotted as tests are made. When a single slump test reaches or goes beyond either the upper or lower action limit, a second test shall immediately be made on the same batch of concrete. The results of the two tests shall be averaged and this average used as the slump of the batch to plot on both the control chart for percent air and the chart for range, and for determining the need for any remedial action. An upper warning limit shall be set at 1/2 inch below the maximum allowable slump on separate control charts for percent air used for each type of mixture as specified in paragraph SLUMP, and an upper action limit line and lower action limit line shall be set at the maximum and minimum allowable slumps, respectively, as specified in the same paragraph. The range between each consecutive slump test for each type of mixture shall be plotted on a single control chart for range on which an upper action limit is set at 2 inches. Samples for slump shall be taken at the mixer, however, the Contractor is responsible for delivering the concrete to the placement site at the stipulated slump. If the Contractor's materials or transportation methods cause slump loss between mixer and the placement, correlation samples shall be taken at the placement site as required by the Contracting Officer and the slump at the mixer controlled as directed.
- d. Slump Corrective Action - Whenever points on the control chart for slump reach the upper warning limit, an adjustment shall be immediately made in the batch weights of water and fine aggregate. The adjustments are to be made so that the total water content does not exceed that amount allowed by the maximum W/C specified, based upon aggregates which are in a saturated surface-dry condition. When a single slump reaches the upper or lower action limit, no further concrete shall be delivered to the placing site until proper adjustments have been made. Immediately after each adjustment, another test shall be made to verify the correctness of the adjustment. Whenever two consecutive slump tests, made during a period when there was no adjustment of batch weights, produce a point on the control chart for range at or above the upper action limit, the concreting operation shall immediately be halted and the Contractor shall take appropriate steps to bring the slump under control. Also, additional slump tests shall be made as directed. All this shall be at no additional cost to the Government.

- e. Temperature - The temperature of the concrete shall be measured when compressive strength specimens are fabricated. Measurement shall be in accordance with ASTM C 1064. The temperature shall be reported along with the compressive strength data.
- f. Compressive-Strength Specimens - At least one set of test specimens shall be made each day on each different concrete mixture placed during the day. Additional sets of test cylinders shall be made, as directed by the Contracting Officer, when the mixture proportions are changed or when low strengths have been detected. A random sampling plan shall be developed by the Contractor and approved by the Contracting Officer prior to the start of construction. The plan shall assure that sampling is done in a completely random and unbiased manner. A set of test specimens for concrete with a 28-day specified strength per paragraph DESIGN REQUIREMENTS shall consist of four cylinders, two to be tested at 7 days and two at 28 days. A set of test specimens for concrete with a 90-day strength per specified paragraph DESIGN REQUIREMENTS shall consist of six cylinders, two tested at 7 days, two at 28 days, and two at 90 days. Test specimens shall be molded and cured in accordance with ASTM C 31 and tested in accordance with ASTM C 39. All compressive-strength tests shall be reported immediately to the Contracting Officer. Quality control charts shall be kept for individual strength tests, moving average for strength, and moving average for range for each mixture. The charts shall be similar to those found in ACI 021489.

3.7.2.7 Inspection Before Placing

Foundation or construction joints, forms, and embedded items shall be inspected for quality by the Contractor in sufficient time prior to each concrete placement to certify to the Contracting Officer that they are ready to receive concrete. The results of each inspection shall be reported in writing.

3.7.2.8 Placing

- a. Placing Inspection - The placing foreman shall supervise all placing operations, shall determine that the correct quality of concrete or grout is placed in each location as directed and shall be responsible for measuring and recording concrete temperatures and ambient temperature hourly during placing operations, weather conditions, time of placement, yardage placed, and method of placement.
- b. Placing Corrective Action - The placing foreman shall not permit batching and placing to begin until he has verified that an adequate number of vibrators in working order and with competent operators are available. Placing shall not be continued if any pile of concrete is inadequately consolidated. If any batch of concrete fails to meet the temperature requirements, immediate steps shall be taken to improve temperature controls.

3.7.2.9 Vibrators

- a. Vibrator Testing and Use - The frequency and amplitude of each vibrator shall be determined in accordance with COE CRD-C 521 prior to initial use and at least once a month when concrete is being placed. Additional tests shall be made as directed when a vibrator does not appear to be adequately consolidating the concrete. The frequency shall be determined at the same time the vibrator is operating in concrete with the tachometer held against the upper end of the vibrator head while almost submerged and just before the vibrator is withdrawn from the concrete. The amplitude shall be determined with the head vibrating in air. Two measurements shall be taken, one near the tip and another near the

upper end of the vibrator head and these results averaged. The make, model, type, and size of the vibrator and frequency and amplitude results shall be reported in writing.

- b. Vibrator Corrective Action - Any vibrator not meeting the requirements of paragraph VIBRATORS shall be immediately removed from service and repaired or replaced.

3.7.2.10 Curing

- a. Moist-Curing Inspections - At least once each shift, and once per day on non-work days an inspection shall be made of all areas subject to moist curing. The surface moisture condition shall be noted and recorded.
- b. Moist-Curing Corrective Action - When a daily inspection report lists an area of inadequate curing, immediate corrective action shall be taken, and the required curing period for such areas shall be extended by one (1) day.
- c. Membrane-Curing Inspection - No curing compound shall be applied until the Contractor's authorized representative has verified that the compound is properly mixed and ready for spraying. At the end of each operation, he shall estimate the quantity of compound used by measurement of the container and the area of concrete surface covered and compute the rate of coverage in square feet per gallon. He shall note whether or not coverage is uniform.
- d. Membrane-Curing Corrective Action - When the coverage rate of the curing compound is less than that specified or when the coverage is not uniform, the entire surface shall be sprayed again.
- e. Sheet-Curing Inspection - At least once each shift and once per day on non-work days, an inspection shall be made of all areas being cured using material sheets. The condition of the covering and the tightness of the laps and tapes shall be noted and recorded.
- f. Sheet-Curing Corrective Action - When a daily inspection report lists any tears, holes, or laps or joints that are not completely closed, the tears and holes shall promptly be repaired or the sheets replaced, the joints closed, and the required curing period for those areas shall be extended by one (1) day.

3.7.2.11 Cold-Weather Protection and Sealed Insulation Curing

At least once each shift and once per day on non-work days, an inspection shall be made of all areas subject to cold-weather protection. The protection system shall be inspected for holes, tears, unsealed joints, or other deficiencies that could result in damage to the concrete. Special attention shall be taken at edges, corners, and thin sections. Any deficiencies shall be noted, corrected, and reported.

3.7.2.12 Cold-Weather Protection Corrective Action

When a daily inspection report lists any holes, tears, unsealed joints, or other deficiencies, the deficiency shall be corrected immediately and the period of protection extended 1 day.

3.7.2.13 Mixer Uniformity

- a. Stationary Mixers - Prior to the start of concrete placing and once every 6 months when concrete is being placed, or once for every 75,000 cubic yards of concrete placed,

whichever results in the longest time interval, uniformity of concrete mixing shall be determined in accordance with ASTM C 94.

- b. Truck Mixers - Prior to the start of concrete placing and at least once every 6 months when concrete is being placed, uniformity of concrete shall be determined in accordance with ASTM C 94. The truck mixers shall be selected randomly for testing. When satisfactory performance is found in one truck mixer, the performance of mixers of substantially the same design and condition of the blades may be regarded as satisfactory.

3.7.2.14 Mixer Uniformity Corrective Action

When a mixer fails to meet mixer uniformity requirements, either the mixer shall be removed from service on the work, the mixing time shall be increased, batching sequence changed, batch size reduced, or adjustments shall be made to the mixer until compliance is achieved.

3.7.3 Reports

All results of tests or inspections conducted shall be reported informally as they are completed and in writing daily. A weekly report shall be prepared for the updating of control charts covering the entire period from the start of the construction season through the current week. During periods of cold-weather protection, reports of pertinent temperatures shall be made daily. These requirements do not relieve the Contractor of the obligation to report certain failures immediately as required in preceding paragraphs. Such reports of failures and the action taken shall be confirmed in writing in the routine reports. The Contracting Officer has the right to examine all test and inspection records.

End of Section

DIVISION 4 - MASONRY

SECTION 04200

MASONRY

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SECTION 04200

MASONRY

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

ACI INTERNATIONAL (ACI)

ACI SP6694 (1994) ACI Detailing Manual

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 82 (1997) Steel Wire, Plain, for Concrete Reinforcement

ASTM A 153 (1995) Zinc Coating (Hot-Dip) on Iron and Steel Hardware

ASTM A 615 (1996a) Deformed and Plain Billet-Steel Bars for Concrete Reinforcement

ASTM C 55 (1997a) Concrete Building Brick

ASTM C 67 (1997) Sampling and Testing Brick and Structural Clay Tile

ASTM C 90 (1997a) Loadbearing Concrete Masonry Units

ASTM C 91 (1998) Masonry Cement

ASTM C 270 (1997a) Mortar for Unit Masonry

ASTM C 476 (1995) Grout for Masonry

ASTM C 494 (1998) Chemical Admixtures for Concrete

ASTM C 578 (1995) Rigid, Cellular Polystyrene Thermal Insulation

ASTM C 641 82(1991) Staining Materials in Lightweight Concrete Aggregates

ASTM C 780 (1996)e1 Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry

ASTM C 1019 89a(1993)e1 Sampling and Testing Grout

ASTM C 1072	(1997) Measurement of Masonry Flexural Bond Strength
ASTM C 1289	(1998) Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board
ASTM C 1388	(1997) Compressive Strength of Masonry Prisms

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with SECTION 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Concrete Masonry Units; GA. Prefaced Concrete Masonry Units; GA. Insulation; GA.

Manufacturer's descriptive data.

SD-04 Drawings

Masonry Work; GA.

Drawings including plans, elevations, and details of wall reinforcement; details of reinforcing bars at corners and wall intersections; offsets; tops, bottoms, and ends of walls; control and expansion joints; and wall openings. Bar splice locations shall be shown. Bent bars shall be identified on a bending diagram and shall be referenced and located on the drawings. Wall dimensions, bar clearances, and wall openings greater than one masonry unit in area shall be shown. No approval will be given to the shop drawings until the Contractor certifies that all openings, including those for mechanical and electrical service, are shown. If, during construction, additional masonry openings are required, the approved shop drawings shall be resubmitted with the additional openings shown along with the proposed changes. Location of these additional openings shall be clearly highlighted. The minimum scale for wall elevations shall be 1/4 inch per foot. Reinforcement bending details shall conform to the requirements of ACI SP6694.

SD-08 Statements

Cold Weather Installation; GA.

Cold weather construction procedures.

SD-09 Reports

Efflorescence Test; GA. Field Testing of Mortar; GA. Field Testing of Grout; GA. Prism tests; GA. Masonry Cement; GA.

Test reports from an approved independent laboratory. Test reports on a previously tested material shall be certified as the same as that proposed for use in this project.

Special Inspection; GA.

Copies of masonry inspector reports.

SD-13 Certificates

Concrete Brick; FIO. Concrete Masonry Units (CMU); FIO. Architectural Concrete Masonry Units; FIO. Control Joint Keys; FIO. Anchors, Ties, and Bar Positioners; FIO. Expansion-Joint Materials; FIO. Joint Reinforcement; FIO. Reinforcing Steel Bars and Rods; FIO. Masonry Cement; FIO. Mortar Coloring; FIO. Insulation; FIO. Precast Concrete Items; FIO. Mortar Admixtures; FIO. Grout Admixtures; FIO.

Certificates of compliance stating that the materials meet the specified requirements.

Insulation; FIO

Certificate attesting that the polyurethane or polyisocyanurate insulation furnished for the project contains recovered material, and showing an estimated percent of such recovered material.

SD-14 Samples

Concrete Masonry Units (CMU); GA. Architectural Concrete Masonry Units; GA. Precast Concrete Items; GA.

Color samples of three stretcher units and one unit for each type of special shape. Units shall show the full range of tan or light brown color and texture.

Anchors, Ties, and Bar Positioners; GA.

Two of each type used.

Expansion-Joint Material; GA.

One piece of each type used.

Joint Reinforcement; GA.

One piece of each type used, including corner and wall intersection pieces, showing at least two cross wires.

Insulation; GA.

One piece of board type insulation, not less than 16 inches by 24 inches in size, containing the label indicating the rated permeance and R-values.

1.3 SAMPLE MASONRY PANELS

After material samples are approved and prior to starting masonry work, sample masonry panels shall be constructed for each type and color of masonry required. At least 48 hours prior to constructing the sample panel or panels, the Contractor shall submit written notification to the Contracting Officer's Representative. Sample panels shall not be built in, or as part of the structure, but shall be located where directed.

1.3.1 Configuration

Panels shall be L-shaped or otherwise configured to represent all of the wall elements. Panels shall be of the size necessary to demonstrate the acceptable level of workmanship for each type of masonry represented on the project. The minimum size of a straight panel or a leg of an L-shaped panel shall be 8 feet long by 4 feet high.

1.3.2 Composition

Panels shall show full color range, texture, and bond pattern of the masonry work. The Contractor's method for mortar joint tooling; grouting of reinforced vertical cores, collar joints, bond beams, and lintels; positioning, securing, and lapping of reinforcing steel; positioning and lapping of joint reinforcement (including prefabricated corners); and cleaning of masonry work shall be demonstrated during the construction of the panels. Installation or application procedures for anchors, wall ties, glass block units, CMU control joints, brick expansion joints, insulation, flashing, brick soldier, row lock courses and weep holes shall be shown in the sample panels. The panels shall contain a masonry bonded corner.

1.3.3 Construction Method

Where anchored veneer walls are required, the Contractor shall demonstrate and receive approval for the method of construction; i.e., either bring up the two wythes together or separately, with the insulation and appropriate ties placed within the specified tolerances across the cavity. Temporary provisions shall be demonstrated to preclude mortar or grout droppings in the cavity and to provide a clear open air space of the dimensions shown on the drawings. Where masonry is to be grouted, the Contractor shall demonstrate and receive approval on the method that will be used to bring up the masonry wythes; support the reinforcing bars; and grout cells, bond beams, lintels, and collar joints using the requirements specified herein. If sealer is specified to be applied to the masonry units, sealer shall be applied to the sample panels. Panels shall be built on a properly designed concrete foundation.

1.3.4 Usage

The completed panels shall be used as the standard of workmanship for the type of masonry represented. Masonry work shall not commence until the sample panel for that type of masonry construction has been completed and approved. Panels shall be protected from the weather and construction operations until the masonry work has been completed and approved. After completion of the work, the sample panels, including all foundation concrete, shall become the property of the Contractor and shall be removed from the construction site.

1.4 DELIVERY, HANDLING, AND STORAGE

Materials shall be delivered, handled, stored, and protected to avoid chipping, breakage, and contact with soil or contaminating material.

1.4.1 Masonry Units

Concrete masonry units shall be covered or protected from inclement weather and shall conform to the moisture content as specified in ASTM C 90 when delivered to the jobsite. Prefabricated lintels shall be marked on top sides to show either the lintel schedule number or the number and size of top and bottom bars.

1.4.2 Reinforcement, Anchors, and Ties

Steel reinforcing bars, coated anchors, ties, and joint reinforcement shall be stored above the ground. Steel reinforcing bars and uncoated ties shall be free of loose mill scale and rust.

1.4.3 Cementitious Materials, Sand and Aggregates

Cementitious and other packaged materials shall be delivered in unopened containers, plainly marked and labeled with manufacturers' names and brands. Cementitious material shall be stored in dry, weathertight enclosures or be completely covered. Cement shall be handled in a manner that will prevent the inclusion of foreign materials and damage by water or dampness. Sand and aggregates shall be stored in a manner to prevent contamination or segregation.

1.5 SPECIAL INSPECTION

A qualified masonry inspector approved by the Contracting Officer shall perform inspection of the masonry work. Minimum qualifications for the masonry inspector shall be 5 years of reinforced masonry inspection experience or acceptance by a State, municipality, or other governmental body having a program of examining and certifying inspectors for reinforced masonry construction. The masonry inspector shall be present during preparation of masonry prisms, sampling and placing of masonry units, placement of reinforcement (including placement of dowels in footings and foundation walls), inspection of grout space, immediately prior to closing of cleanouts, and during grouting operations. The masonry inspector shall assure Contractor compliance with the drawings and specifications. The masonry inspector shall keep a complete record of all inspections and shall submit daily written reports to the Quality Control Supervisory Representative reporting the quality of masonry construction.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

The source of materials which will affect the appearance of the finished work shall not be changed after the work has started except with Contracting Officer's approval.

2.2 CLAY OR SHALE BRICK - NONE THIS PROJECT

2.3 CONCRETE BRICK AND FACING UNITS

Concrete brick shall conform to ASTM C 55, Type I, Grade N-I. Concrete brick may be used where necessary for filling out in concrete masonry unit construction.

2.4 CONCRETE MASONRY UNITS (CMU)

Hollow and solid concrete masonry units shall conform to ASTM C 90, Type I, Lightweight, Grade N-1 moisture controlled units of nominal size 16 inches long x 8 inches high x thickness indicated. Exposed faces shall be free of cracks and other defects.

2.4.1 Aggregates

Lightweight aggregates and blends of lightweight and heavier aggregates in proportions used in producing the units, shall comply with the following requirements when tested for stain-producing iron compounds in accordance with ASTM C 641: by visual classification method, the iron stain deposited on the filter paper shall not exceed the "light stain" classification.

2.4.2 Kinds and Shapes

Units shall be modular in size and shall include closer, jamb, header, lintel, and bond beam units and special shapes and sizes to complete the work as indicated. In exposed interior masonry surfaces, units having a bullnose shall be used for vertical external corners except at door, window, and louver jambs. Radius of the bullnose shall be 1 inch. Units used in exposed masonry surfaces in any one building shall have a uniform fine to medium texture and a uniform color.

2.4.3 Architectural Units

Architectural Veneer Units shall be nominal 4 inch thickness and have a patterned exposed face and shall be integrally colored during manufacture. Color shall be tan or light brown. "Full Face" units shall be split face over entire exterior face. "Ribbed" units shall be 6 flute or 8 flute split face ribbed pattern.

2.5 MORTAR

Mortar shall be Type S in accordance with the proportion specification of ASTM C 270 except Type S cement-lime mortar proportions shall be 1 part cement, 1/2 part lime and 4-1/2 parts aggregate; when masonry cement ASTM C 91 is used the maximum air content shall be limited to 12 percent and performance equal to cement-lime mortar shall be verified. Evaluation of performance shall be based on ASTM C 780 and ASTM C 1072. Cement shall have a low alkali content and be of one brand. Aggregates shall be from one source.

2.5.1 Admixtures

In cold weather, a non-chloride based accelerating admixture may be used subject to approval. Accelerating admixture shall be non-corrosive, shall contain less than 0.2 percent chlorides, and shall conform to ASTM C 494, Type C.

2.5.2 Coloring

Mortar coloring shall be added to the mortar used for exposed masonry surfaces to produce a uniform color matching adjacent masonry units. Mortar coloring shall not exceed 3 percent of the weight of cement for carbon black and ten percent of the weight of cement for all other pigments. Mortar coloring shall be chemically inert, of finely ground limeproof pigment, and furnished in accurately pre-measured and packaged units that can be added to a measured amount of cement.

2.6 GROUT

Grout shall conform to ASTM C 476. Cement used in grout shall have a low alkali content. Grout slump shall be between 8 and 10 inches. Grout shall be used subject to the limitations of Table III. Proportions shall not be changed and materials with different physical or chemical characteristics shall

not be used in grout for the work unless additional evidence is furnished that the grout meets the specified requirements.

2.6.1 Admixtures

In cold weather, a non-chloride based accelerating admixture may be used subject to approval. Accelerating admixture shall be non-corrosive, shall contain less than 0.2 percent chlorides, and shall conform to ASTM C 494, Type C.

2.6.2 Grout Barriers

Grout barriers for vertical cores shall consist of fine mesh wire, fiberglass, or expanded metal.

2.7 ANCHORS, TIES, AND BAR POSITIONERS

Anchors and ties shall be fabricated without drips or crimps and shall be zinc-coated in accordance with ASTM A 153, Class B-2. Steel wire used for anchors and ties shall be fabricated from steel wire conforming to ASTM A 82. Anchors and ties shall be sized to provide a minimum of 5/8 inch mortar cover from either face.

2.7.1 Wall Ties

Wall ties shall be rectangular-shaped fabricated of 16 gauge zinc-coated steel plate and pintel. Rectangular wall ties shall be rated for Seismic Performance categories D&E. Wall ties shall be spaced a maximum of 16 inches on center. Plate shall engage continuous wire reinforcing in backup wythe and single wire reinforcing in veneer wythe.

2.7.2 Dovetail Anchors

Dovetail anchors shall be rated for Seismic Performance category D&E of 12 zinc-coated steel plate, and attached to a 12 gauge or heavier steel dovetail section. Cells within vertical planes of these anchors shall be filled solid with grout for full height of walls or partitions, or solid units may be used. Dovetail slots are specified in Section 03301 CAST-IN-PLACE STRUCTURAL CONCRETE.

2.7.3 Bar Positioners

Bar positioners, used to prevent displacement of reinforcing bars during the course of construction, shall be factory fabricated from 9 gauge steel wire or equivalent, and coated with a hot-dip galvanized finish. Not more than one wire shall cross the cell.

2.8 JOINT REINFORCEMENT

Joint reinforcement shall be factory fabricated from steel wire conforming to ASTM A 82, welded construction. Tack welding will not be acceptable in reinforcement used for wall ties. Wire shall have zinc coating conforming to ASTM A 153, Class B-2. Longitudinal wires shall be a minimum of 3/16" diameter. Cross wire to be 9 gauge wire. Reinforcement shall be ladder type design meeting requirements for Seismic Performance category D&E, having one longitudinal wire in the mortar bed of each face shell for hollow units and one wire for solid units. Joint reinforcement shall be placed a minimum of 5/8 inch cover from either face. The distance between crosswires shall not exceed 16 inches. Joint reinforcement for straight runs shall be furnished in flat sections not less than 10 feet long. Joint reinforcement shall be provided with factory formed corners and intersections.

2.9 REINFORCING STEEL BARS AND RODS

Reinforcing steel bars and rods shall conform to ASTM A 615, Grade 60.

2.10 EXPANSION-JOINT MATERIALS

Backer rod and sealant shall be adequate to accommodate joint compression equal to 50 percent of the width of the joint. The backer rod shall be compressible rod stock of polyethylene foam, polyurethane foam, butyl rubber foam, or other flexible, nonabsorptive material as recommended by the sealant manufacturer. Sealant shall conform to Section 07900 JOINT SEALING.

2.11 INSULATION

2.11.1 Rigid Board-Type Insulation

Rigid board-type insulation shall be extruded polystyrene, polyurethane, or polyisocyanurate. Polystyrene shall conform to ASTM C 578. Polyurethane or polyisocyanurate shall conform to ASTM C 1289, Type I, Class 2, faced with aluminum foil on both sides of the foam. The insulation shall be a standard product and shall be marked with not less than the manufacturer's trademark or name, the specification number, the permeance and R-values.

2.11.1.1 Insulation Thickness and Air Space

The cavity space shall allow for a maximum insulation thickness of 1 inch, and a minimum air space of 3/4 inch.

2.11.1.2 Aged R-Value

The insulation shall provide a minimum aged R-value of 5 for the overall thickness. The aged R-value shall be determined at 75 degrees F in accordance with the appropriate referenced specification. The stated R-value of the insulation shall be certified by an independent testing laboratory or certified by an independent Registered Professional Engineer if tests are conducted in the manufacturer's laboratory.

2.11.1.3 Recovered Material

Insulation shall contain the highest practicable percentage of recovered material derived from solid waste (but material reused in the manufacturing process cannot be counted toward the percentage of recovered material). Where two materials have the same price and performance, the one containing the higher recovered material content shall be provided. The polyurethane or polyisocyanurate foam shall have a minimum recovered material content of 9 percent by weight of the core material.

2.11.2 Insulation Adhesive

Insulation adhesive shall be specifically prepared to adhere the insulation to the masonry and, where applicable, to the thru-wall flashing. The adhesive shall not deleteriously affect the insulation, and shall have a record of satisfactory and proven performance for the conditions under which to be used.

2.12 FLASHING

Flashing shall be as specified in Section 07600 SHEET METALWORK, GENERAL.

PART 3 EXECUTION

3.1 ENVIRONMENTAL REQUIREMENTS

3.1.1 Hot Weather Installation

The following precautions shall be taken if masonry is erected when the ambient air temperature is more than 99 degrees F in the shade and the relative humidity is less than 50 percent. All masonry materials shall be shaded from direct sunlight; mortar beds shall be spread no more than 4 feet ahead of masonry; masonry units shall be set within one minute of spreading mortar; and after erection, masonry shall be protected from direct exposure to wind and sun for 48 hours.

3.1.2 Cold Weather Installation

Before erecting masonry when ambient temperature or mean daily air temperature falls below 40 degrees F, a written statement of proposed cold weather construction procedures shall be submitted for approval. The following precautions shall be taken during all cold weather erection.

3.1.2.1 Preparation

Ice or snow formed on the masonry bed shall be thawed by the application of heat. Heat shall be applied carefully until the top surface of the masonry is dry to the touch. Sections of masonry deemed frozen and damaged shall be removed before continuing construction of those sections.

- a. Air Temperature 40 to 32 Degrees F. Sand or mixing water shall be heated to produce mortar temperatures between 40 degrees F and 120 degrees F.
- b. Air Temperature 32 to 25 Degrees F. Sand and mixing water shall be heated to produce mortar temperatures between 40 degrees F and 120 degrees F. Temperature of mortar on boards shall be maintained above freezing.
- c. Air Temperature 25 to 20 Degrees F. Sand and mixing water shall be heated to provide mortar temperatures between 40 degrees F and 120 degrees F. Temperature of mortar on boards shall be maintained above freezing. Sources of heat shall be used on both sides of walls under construction. Windbreaks shall be employed when wind is in excess of 15 mph.
- d. Air Temperature 20 Degrees F and below. Sand and mixing water shall be heated to provide mortar temperatures between 40 degrees F and 120 degrees F. Enclosure and auxiliary heat shall be provided to maintain air temperature above 32 degrees F. Temperature of units when laid shall not be less than 20 degrees F.

3.1.2.2 Completed Masonry and Masonry Not Being Worked On

- a. Mean daily air temperature 40 degrees F to 32 degrees F. Masonry shall be protected from rain or snow for 24 hours by covering with weather-resistive membrane.
- b. Mean daily air temperature 32 degrees F to 25 degrees F. Masonry shall be completely covered with weather-resistant membrane for 24 hours.

- c. Mean Daily Air Temperature 25 Degrees F to 20 Degrees F. Masonry shall be completely covered with insulating blankets or equally protected for 24 hours.
- d. Mean Daily Temperature 20 Degrees F and Below. Masonry temperature shall be maintained above 32 degrees F for 24 hours by enclosure and supplementary heat, by electric heating blankets, infrared heat lamps, or other approved methods.

3.2 LAYING MASONRY UNITS

Masonry units shall be laid in running bond pattern. Facing courses shall be level with back-up courses, unless the use of adjustable ties has been approved in which case the tolerances shall be plus or minus 1/2 inch. Each unit shall be adjusted to its final position while mortar is still soft and plastic. Units that have been disturbed after the mortar has stiffened shall be removed, cleaned, and relaid with fresh mortar. Air spaces, cavities, chases, expansion joints, and spaces to be grouted shall be kept free from mortar and other debris. Units used in exposed masonry surfaces shall be free from chipped edges or other imperfections detracting from the appearance of the finished work. Vertical joints shall be kept plumb. Ribbed faces shall be installed so that ribs shall be properly aligned vertically in the completed wall. Units being laid and surfaces to receive units shall be free of water film and frost. Solid units shall be laid in a nonfurrowed full bed of mortar. Mortar for veneer wythes shall be beveled and sloped toward the center of the wythe from the cavity side. Units shall be shoved into place so that the vertical joints are tight. Vertical joints of veneer units and the vertical face shells of concrete masonry units, except where indicated at control, expansion, and isolation joints, shall be completely filled with mortar. Mortar will be permitted to protrude up to 1/2 inch into the space or cells to be grouted. Means shall be provided to prevent mortar from dropping into the space below. In double wythe construction, the inner wythe may be brought up not more than 16 inches ahead of the outer wythe. Collar joints shall be filled with mortar or grout during the laying of the facing wythe, and filling shall not lag the laying of the facing wythe by more than 8 inches.

3.2.1 Surface Preparation

Surfaces upon which masonry is placed shall be cleaned of laitance, dust, dirt, oil, organic matter, or other foreign materials and shall be slightly roughened to provide a surface texture with a depth of at least 1/8 inch. Sandblasting shall be used, if necessary, to remove laitance from pores and to expose the aggregate.

3.2.2 Forms and Shores

Forms and shores shall be sufficiently rigid to prevent deflections which may result in cracking or other damage to supported masonry and sufficiently tight to prevent leakage of mortar and grout. Supporting forms and shores shall not be removed in less than 10 days.

3.2.3 Concrete Masonry Units

Units in piers, pilasters, columns, lintels, and beams, and where cells are to be filled with grout shall be full bedded in mortar under both face shells and webs. Other units shall be full bedded under both face shells. Head joints shall be filled solidly with mortar for a distance in from the face of the unit not less than the thickness of the face shell. Jamb units shall be of the shapes and sizes to conform with wall units. Solid units may be incorporated in the masonry work where necessary to fill out at corners, and elsewhere as approved. Double walls shall be stiffened at wall-mounted plumbing fixtures by use of strap anchors, two above each fixture and two below each fixture, located to avoid pipe runs, and

extending from center to center of the double wall. Walls and partitions shall be adequately reinforced for support of wall-hung plumbing fixtures when chair carriers are not specified.

3.2.4 Tolerances

Masonry shall be laid plumb, true to line, with courses level. Bond pattern shall be kept plumb throughout. Corners shall be square unless noted otherwise. Except for walls constructed of prefaced concrete masonry units, masonry shall be laid within the following tolerances (plus or minus unless otherwise noted):

TABLE II
TOLERANCES

<u>Variation from the plumb in the lines and surfaces of columns, walls and arises</u>	
In adjacent masonry units	1/8 inch
In 10 feet	1/4 inch
In 20 feet	3/8 inch
In 40 feet or more	1/2 inch
<u>Variations from the plumb for external corners, expansion joints, and other conspicuous lines</u>	
In 20 feet	1/4 inch
In 40 feet or more	1/2 inch
<u>Variations from the level for exposed lintels, sills, parapets, horizontal grooves, and other conspicuous lines</u>	
In 20 feet	1/4 inch
In 40 feet or more	1/2 inch
<u>Variation from level for bed joints and top surfaces of bearing walls</u>	
In 10 feet	1/4 inch
In 40 feet or more	1/2 inch
<u>Variations from horizontal lines</u>	
In 10 feet	1/4 inch
In 20 feet	3/8 inch
In 40 feet or more	1/2 inch
<u>Variations in cross sectional dimensions of columns and in thickness of walls</u>	
Minus	1/4 inch
Plus	1/2 inch

3.2.5 Cutting and Fitting

Full units of the proper size shall be used wherever possible, in lieu of cut units. Cutting and fitting, including that required to accommodate the work of others, shall be done by masonry mechanics using power masonry saws. Concrete masonry units may be wet or dry cut. Wet cut units, before being placed in the work, shall be dried to the same surface-dry appearance as uncut units being laid in the wall. Cut edges shall be clean, true and sharp. Openings in the masonry shall be made carefully so that wall plates, cover plates or escutcheons required by the installation will completely conceal the openings and will have bottoms parallel with the masonry bed joints. Reinforced masonry lintels shall be provided above openings over 12 inches wide for pipes, ducts, cable trays, and other wall penetrations, unless steel sleeves are used.

3.2.6 Jointing

Joints shall be tooled when the mortar is thumbprint hard. Horizontal joints shall be tooled last. Joints shall be brushed to remove all loose and excess mortar. Mortar joints shall be finished as follows:

3.2.6.1 Flush Joints

Joints in concealed masonry surfaces and joints at electrical outlet boxes in wet areas shall be flush cut. Flush cut joints shall be made by cutting off the mortar flush with the face of the wall. Flush joints for architectural units, such as fluted units, shall completely fill both the head and bed joints.

3.2.6.2 Tooled Joints

Joints in exposed exterior and interior masonry surfaces shall be tooled slightly concave. Joints shall be tooled with a jointer slightly larger than the joint width so that complete contact is made along the edges of the unit. Tooling shall be performed so that the mortar is compressed and the joint surface is sealed. Jointer of sufficient length shall be used to obtain a straight and true mortar joint.

3.2.6.3 Door and Window Frame Joints

On the exposed interior side of exterior frames, joints between frames and abutting masonry walls shall be raked to a depth of 3/8 inch. On the exterior side of exterior frames, joints between frames and abutting masonry walls shall be raked to a depth of 3/8 inch.

3.2.7 Joint Widths

Joint widths shall be as follows:

3.2.7.1 Concrete Masonry Units

Concrete masonry units shall have 3/8 inch joints, except for prefaced concrete masonry units.

3.2.8 Embedded Items

Spaces around built-in items shall be filled with mortar. Openings around flush-mount electrical outlet boxes in wet locations shall be pointed with mortar. Anchors, ties, wall plugs, accessories, flashing, pipe sleeves and other items required to be built-in shall be embedded as the masonry work progresses.

Anchors, ties and joint reinforcement shall be fully embedded in the mortar. Cells receiving anchor bolts and cells of the first course below bearing plates shall be filled with grout.

3.2.9 Unfinished Work

Unfinished work shall be stepped back for joining with new work. Tothing may be resorted to only when specifically approved. Loose mortar shall be removed and the exposed joints shall be thoroughly cleaned before laying new work.

3.2.10 Masonry Wall Intersections

Each course shall be masonry bonded at corners and elsewhere as shown. Masonry walls shall be anchored or tied together at corners and intersections with bond beam reinforcement and prefabricated corner or tee pieces of joint reinforcement as shown.

3.2.11 Partitions

Partitions shall be continuous from floor to underside of floor or roof deck where shown. Where suspended ceilings on both sides of partitions are indicated, the partitions other than those shown to be continuous may be stopped approximately 4 inches above the ceiling level. An isolation joint shall be placed in the intersection between partitions and structural or exterior walls as shown. Interior partitions having 4 inch nominal thick units shall be tied to intersecting partitions of 4 inch units, 5 inches into partitions of 6 inch units, and 7 inches into partitions of 8 inch or thicker units. Cells within vertical plane of ties shall be filled solid with grout for full height of partition or solid masonry units may be used. Interior partitions having masonry walls over 4 inches thick shall be tied together with joint reinforcement. Partitions containing joint reinforcement shall be provided with prefabricated pieces at corners and intersections or partitions.

3.3 ANCHORED VENEER CONSTRUCTION

The inner and outer wythes shall be completely separated by a continuous airspace as shown on the drawings. Both the inner and the outer wythes shall be laid up together except when adjustable joint reinforcement assemblies are approved for use. When both wythes are not brought up together, through-wall flashings shall be protected from damage until they are fully enclosed in the wall. The airspace between the wythes shall be kept clear and free of mortar droppings by temporary wood strips laid on the wall ties and carefully lifted out before placing the next row of ties. A coarse gravel or drainage material shall be placed behind the weep holes in the cavity to a minimum depth of 4 inches of coarse aggregate or 10 inches of drainage material to keep mortar droppings from plugging the weep holes.

3.4 WEEP HOLES

Weep holes shall be provided not more than 24 inches on centers in mortar joints of the exterior wythe above wall flashing, over foundations, bond beams, and any other horizontal interruptions of the cavity. Weep holes shall be formed by placing short lengths of well-greased No. 10, 5/16 inch nominal diameter, braided cotton sash cord in the mortar and withdrawing the cords after the wall has been completed. Other approved methods may be used for providing weep holes. Weep holes shall be kept free of mortar and other obstructions.

3.5 COMPOSITE WALLS

Masonry wythes shall be tied together with joint reinforcement or with unit wall ties. Facing shall be anchored to concrete backing with dovetail anchors set in slots built in the face of the concrete as specified in Section 03301 CAST-IN-PLACE STRUCTURAL CONCRETE. The facing wythe shall be anchored or tied to the backup at a maximum spacing of 16 inches on center vertically and 24 inches on center horizontally. Unit ties shall be spaced not over 24 inches on centers horizontally, in courses not over 16 inches apart vertically, staggered in alternate courses. Ties shall be laid not closer than 5/8 inch to either masonry face. Ties shall not extend through control joints. Collar joints between masonry facing and masonry backup shall be filled solidly with grout.

3.6 MORTAR

Mortar shall be mixed in a mechanically operated mortar mixer for at least 3 minutes, but not more than 5 minutes. Measurement of ingredients for mortar shall be by volume. Ingredients not in containers, such as sand, shall be accurately measured by the use of measuring boxes. Water shall be mixed with the dry ingredients in sufficient amount to provide a workable mixture which will adhere to the vertical surfaces of masonry units. Mortar that has stiffened because of loss of water through evaporation shall be retempered by adding water to restore the proper consistency and workability. Mortar that has reached its initial set or that has not been used within 2-1/2 hours after mixing shall be discarded.

3.7 REINFORCING STEEL

Reinforcement shall be cleaned of loose, flaky rust, scale, grease, mortar, grout, or other coating which might destroy or reduce its bond prior to placing grout. Bars with kinks or bends not shown on the drawings shall not be used. Reinforcement shall be placed prior to grouting. Unless otherwise indicated, vertical wall reinforcement shall extend to within 2 inches of tops of walls.

3.7.1 Positioning Bars

Vertical bars shall be accurately placed within the cells at the positions indicated on the drawings. A minimum clearance of 1/2 inch shall be maintained between the bars and masonry units. Minimum clearance between parallel bars shall be one diameter of the reinforcement. Vertical reinforcing may be held in place using bar positioners located near the ends of each bar and at intermediate intervals of not more than 192 diameters of the reinforcement. Column and pilaster ties shall be wired in position around the vertical steel. Ties shall be in contact with the vertical reinforcement and shall not be placed in horizontal bed joints.

3.7.2 Splices

Bars shall be lapped a minimum of 48 diameters of the reinforcement. Welded or mechanical connections shall develop at least 125 percent of the specified yield strength of the reinforcement.

3.8 JOINT REINFORCEMENT

Joint reinforcement shall be installed at 16 inches on center or as indicated. Reinforcement shall be lapped not less than 6 inches. Prefabricated sections shall be installed at corners and wall intersections. The longitudinal wires of joint reinforcement shall be placed to provide not less than 5/8 inch cover to either face of the unit.

3.9 PLACING GROUT

Cells containing reinforcing bars shall be filled with grout. Hollow masonry units in walls or partitions supporting plumbing, heating, or other mechanical fixtures, voids at door and window jambs, and other indicated spaces shall be filled solid with grout. Cells under lintel bearings on each side of openings shall be filled solid with grout for full height of openings. Lintels, and bond beams shall be filled solid with grout. Units other than open end units may require grouting each course to preclude voids in the units. Grout not in place within 1-1/2 hours after water is first added to the batch shall be discarded. Sufficient time shall be allowed between grout lifts to preclude displacement or cracking of face shells of masonry units. If blowouts, flowouts, misalignment, or cracking of face shells should occur during construction, the wall shall be torn down and rebuilt.

3.9.1 Vertical Grout Barriers for Fully Grouted Walls

Grout barriers shall be provided not more than 30 feet apart, or as required, to limit the horizontal flow of grout for each pour.

3.9.2 Horizontal Grout Barriers

Grout barriers shall be embedded in mortar below cells of hollow units receiving grout.

3.9.3 Grout Holes and Cleanouts

3.9.3.1 Grout Holes

Grouting holes shall be provided in slabs, spandrel beams, and other in-place overhead construction. Holes shall be located over vertical reinforcing bars or as required to facilitate grout fill in bond beams. Additional openings spaced not more than 16 inches on centers shall be provided where grouting of all hollow unit masonry is indicated. Openings shall not be less than 4 inches in diameter or 3 by 4 inches in horizontal dimensions. Upon completion of grouting operations, grouting holes shall be plugged and finished to match surrounding surfaces.

3.9.3.2 Cleanouts for Hollow Unit Masonry Construction

Cleanout holes shall be provided at the bottom of every pour in cores containing vertical reinforcement when the height of the grout pour exceeds 5 feet. Where all cells are to be grouted, cleanout courses shall be constructed using bond beam units in an inverted position to permit cleaning of all cells. Cleanout holes shall be provided at a maximum spacing of 32 inches where all cells are to be filled with grout. A new series of cleanouts shall be established if grouting operations are stopped for more than 4 hours. Cleanouts shall not be less than 3 by 4 inch openings cut from one face shell. Manufacturer's standard cutout units may be used at the Contractor's option. Cleanout holes shall not be closed until masonry work, reinforcement, and final cleaning of the grout spaces have been completed and inspected. For walls which will be exposed to view, cleanout holes shall be closed in an approved manner to match surrounding masonry.

3.9.4 Grouting Equipment

3.9.4.1 Grout Pumps

Pumping through aluminum tubes will not be permitted. Pumps shall be operated to produce a continuous stream of grout without air pockets, segregation, or contamination. Upon completion of

each day's pumping, waste materials and debris shall be removed from the equipment, and disposed of outside the masonry.

3.9.4.2 Vibrators

Internal vibrators shall maintain a speed of not less than 5,000 impulses per minute when submerged in the grout. At least one spare vibrator shall be maintained at the site at all times. Vibrators shall be applied at uniformly spaced points not further apart than the visible effectiveness of the machine. Duration of vibration shall be limited to time necessary to produce satisfactory consolidation without causing segregation.

3.9.5 Grout Placement

Masonry shall be laid to the top of a pour before placing grout. Grout shall not be placed in two-wythe solid unit masonry cavity until mortar joints have set for at least 3 days during hot weather and 5 days during cold damp weather. Grout shall not be placed in hollow unit masonry until mortar joints have set for at least 24 hours. Grout shall be placed using a hand bucket, concrete hopper, or grout pump to completely fill the grout spaces without segregation of the aggregates. Vibrators shall not be inserted into lower pours that are in a semi-solidified state. The height of grout pours and type of grout used shall be limited by the dimensions of grout spaces as indicated in Table III. Low-lift grout methods may be used on pours up to and including 5 feet in height. High-lift grout methods shall be used on pours exceeding 5 feet in height.

3.9.5.1 Low-Lift Method

Grout shall be placed at a rate that will not cause displacement of the masonry due to hydrostatic pressure of the grout. Mortar protruding more than 1/2 inch into the grout space shall be removed before beginning the grouting operation. Grout pours 12 inches or less in height shall be consolidated by mechanical vibration or by puddling. Grout pours over 12 inches in height shall be consolidated by mechanical vibration and reconsolidated by mechanical vibration after initial water loss and settlement has occurred. Vibrators shall not be inserted into lower pours that are in a semi-solidified state. Low-lift grout shall be used subject to the limitations of Table III.

TABLE III

POUR HEIGHT AND TYPE OF GROUT FOR VARIOUS GROUT SPACE DIMENSIONS

Maximum Grout Pour Height (feet) (4)	Minimum Dimensions of the Total Clear Areas Within Grout Spaces and Cells (in.) (1,2)			
	Grout Type	Grouting Procedure	Multiwythe Masonry (3)	Hollow-unit Masonry
1	Fine	Low Lift	3/4	1-1/2 x 2
5	Fine	Low Lift	2	2 x 3
8	Fine	High Lift	2	2 x 3
12	Fine	High Lift	2-1/2	2-1/2 x 3
24	Fine	High Lift	3	3 x 3
1	Coarse	Low Lift	1-1/2	1-1/2 x 3

5	Coarse	Low Lift	2	2-1/2 x 3
8	Coarse	High Lift	2	3 x 3
12	Coarse	High Lift	2-1/2	3 x 3
24	Coarse	High Lift	3	3 x 4

Notes:

- (1) The actual grout space or cell dimension must be larger than the sum of the following items:
 - a) The required minimum dimensions of total clear areas given in the table above;
 - b) The width of any mortar projections within the space;
 - c) The horizontal projections of the diameters of the horizontal reinforcing bars within a cross section of the grout space or cell.
- (2) The minimum dimensions of the total clear areas shall be made up of one or more open areas, with at least one area being 3/4 inch or greater in width.
- (3) For grouting spaces between masonry wythes.
- (4) Where only cells of hollow masonry units containing reinforcement are grouted, the maximum height of the pour shall not exceed the distance between horizontal bond beams.

3.10 BOND BEAMS

Bond beams shall be filled with grout and reinforced as indicated on the drawings. Grout barriers shall be installed under bond beam units to retain the grout as required. Reinforcement shall be continuous, including around corners, except through control joints or expansion joints, unless otherwise indicated on the drawings. Where splices are required for continuity, reinforcement shall be lapped 48 bar diameters. A minimum clearance of 1/2 inch shall be maintained between reinforcement and interior faces of units.

3.11 CONCRETE MASONRY VENEER JOINTS

Concrete masonry veneer joints shall be provided and constructed as shown on the drawings. Joints shall be kept free of mortar and other debris.

3.12 SHELF ANGLES

Shelf angles shall be adjusted as required to keep the masonry level and at the proper elevation. Shelf angles shall be galvanized. Shelf angles shall be provided in sections not longer than 10 feet and installed with a 1/4 inch gap between sections. Shelf angles shall be mitered and welded at building corners with each angle not shorter than 4 feet, unless limited by wall configuration.

3.13 LINTELS

3.13.1 Masonry Lintels

Masonry lintels shall be constructed with lintel units filled solid with grout in all courses and reinforced with a minimum of two No. 4 bars in the bottom course unless otherwise indicated on the drawings. Lintel reinforcement shall extend beyond each side of masonry opening 40 bar diameters or 24 inches, whichever is greater. Reinforcing bars shall be supported in place prior to grouting and shall be located 1/2 inch above the bottom inside surface of the lintel unit.

3.13.2 Precast Concrete and Steel Lintels

Precast concrete and steel lintels shall be as shown on the drawings. Lintels shall be set in a full bed of mortar with faces plumb and true. Steel and precast lintels shall have a minimum bearing length of 8 inches unless otherwise indicated on the drawings.

3.14 ANCHORAGE TO CONCRETE AND STRUCTURAL STEEL

3.14.1 Anchorage to Concrete

Anchorage of masonry to the face of concrete columns, beams, or walls shall be with dovetail anchors spaced not over 16 inches on centers vertically and 24 inches on center horizontally.

3.15 INSULATION

Anchored veneer walls shall be insulated, where shown, by installing board-type insulation on the cavity side of the inner wythe. Board type insulation shall be applied directly to the masonry or thru-wall flashing with adhesive. Insulation shall be neatly fitted between obstructions without impaling of insulation on ties or anchors. The insulation shall be applied in parallel courses with vertical joints breaking midway over the course below and shall be applied in moderate contact with adjoining units without forcing, and shall be cut to fit neatly against adjoining surfaces.

3.16 POINTING AND CLEANING

After mortar joints have attained their initial set, but prior to hardening, mortar and grout daubs or splashings shall be completely removed from masonry-unit surfaces that will be exposed or painted. Before completion of the work, defects in joints of masonry to be exposed or painted shall be raked out as necessary, filled with mortar, and tooled to match existing joints. Immediately after grout work is completed, scum and stains which have percolated through the masonry work shall be removed using a high pressure stream of water and a stiff bristled brush. Masonry surfaces shall not be cleaned, other than removing excess surface mortar, until mortar in joints has hardened. Masonry surfaces shall be left clean, free of mortar daubs, dirt, stain, and discoloration, including scum from cleaning operations, and with tight mortar joints throughout. Metal tools and metal brushes shall not be used for cleaning.

3.16.1 Concrete Masonry Unit and Concrete Brick Surfaces

Exposed concrete masonry unit and concrete brick surfaces shall be dry-brushed at the end of each day's work and after any required pointing, using stiff-fiber bristled brushes.

3.17 BEARING PLATES

Bearing plates for beams, joists, joist girders and similar structural members shall be set to the proper line and elevation with damp-pack bedding mortar, except where non-shrink grout is indicated. Bedding mortar and non-shrink grout shall be as specified in Section 03301 CAST-IN-PLACE STRUCTURAL CONCRETE.

3.18 PROTECTION

Facing materials shall be protected against staining. Top of walls shall be covered with nonstaining waterproof covering or membrane when work is not in progress. Covering of the top of the unfinished

walls shall continue until the wall is waterproofed with a complete roof or parapet system. Covering shall extend a minimum of 2 feet down on each side of the wall and shall be held securely in place. Before starting or resuming, top surface of masonry in place shall be cleaned of loose mortar and foreign material.

3.19 TEST REPORTS

3.19.1 Field Testing of Mortar

At least three specimens of mortar shall be taken each day. A layer of mortar 1/2 to 5/8 inch thick shall be spread on the masonry units and allowed to stand for one minute. The specimens shall then be prepared and tested for compressive strength in accordance with ASTM C 780.

3.19.2 Field Testing of Grout

Field sampling and testing of grout shall be in accordance with the applicable provisions of ASTM C 1019. A minimum of three specimens of grout per day shall be sampled and tested. Each specimen shall have a minimum ultimate compressive strength of 2000 psi at 28 days.

3.19.3 Efflorescence Test

Brick which will be exposed to weathering shall be tested for efflorescence. Tests shall be scheduled far enough in advance of starting masonry work to permit retesting if necessary. Sampling and testing shall conform to the applicable provisions of ASTM C 67. Units meeting the definition of "effloresced" will be subjected to rejection.

3.19.4 Prism Tests

At least one prism test sample shall be made for each 5,000 square feet of wall but not less than three such samples shall be made for any building. Three prisms shall be used in each sample. Prisms shall be tested in accordance with ASTM C 1388. Seven-day tests may be used provided the relationship between the 7- and 28-day strengths of the masonry is established by the tests of the materials used. Compressive strength shall not be less than 1800 psi at 28 days. If the compressive strength of any prism falls below the specified value by more than 500 psi, steps shall be taken to assure that the load-carrying capacity of the structure is not jeopardized. If the likelihood of low-strength masonry is confirmed and computations indicate that the load-carrying capacity may have been significantly reduced, tests of cores drilled, or prisms sawed, from the area in question may be required. In such case, three specimens shall be taken for each prism test more than 500 psi below the specified value. Masonry in the area in question shall be considered structurally adequate if the average compressive strength of three specimens is equal to at least 85 percent of the specified value, and if the compressive strength of no single specimen is less than 75 percent of the specified value. Additional testing of specimens extracted from locations represented by erratic core or prism strength test results shall be permitted.

End of Section

DIVISION 5 - METALS

SECTION 05101

METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS

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SECTION 05101

METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN GEAR MANUFACTURERS ASSOCIATION (AGMA)

AGMA 2005-C	(1996) Design Manual for Bevel Gears
AGMA 6001-D	(1997) Design and Selection of Components for Enclosed Gear Drives

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 123	(1997a) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 325	(1997) Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A 380	(1996) Cleaning and Descaling Stainless Steel Parts, Equipment, and Systems
ASTM A 490	(1997) Heat-Treated Steel Structural Bolts, 150 ksi Minimum Tensile Strength
ASTM A 514/A 514M	(1994a) High-Yield-Strength, Quenched and Tempered Alloy Steel Plate, Suitable for Welding
ASTM A 780	(1993a) Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM B 177	(1993) Chromium Electroplating on Steel for Engineering Use
ASTM B 766	86(1993)e1 Electrodeposited Coatings of Cadmium
ASTM E 165	(1995) Liquid Penetrant Examination Inspection Method
ASTM E 709	(1995) Magnetic Particle Examination

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B4.1	(1967; R 1994) Preferred Limits and Fits for Cylindrical Parts
ASME B46.1	(1995) Surface Texture (Surface Roughness, Waviness, and Lay)
ASME BPV IX	(1995) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1	(1998) Structural Welding Code - Steel
AWS D1.2	(1997) Structural Welding Code - Aluminum

1.2 SUBMITTALS

Government approval is required for all submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-04 Drawings

Detail Drawings; GA.

Detail drawings for metalwork and machine work shall be submitted and approved prior to fabrication.

SD-07 Schedules

Materials Orders; FIO.

Copies of purchase orders, mill orders, shop orders and work orders for materials shall be submitted prior to the use of the materials in the work.

Materials List; FIO.

Materials list for fabricated items shall be submitted at the time of submittal of detail drawings.

Shipping Bill; FIO.

Shipping bill shall be submitted with the delivery of finished pieces to the site.

SD-08 Statements

Welding Procedures for Structural Steel; GA.

Schedules of welding procedures for steel structures shall be submitted and approved prior to commencing fabrication.

Welding of Aluminum; GA.

Schedules of welding processes for aluminum fabrications shall be submitted and approved prior to commencing fabrication.

Structural Steel Welding Repairs; GA.

Welding repair plans for steel shall be submitted and approved prior to making repairs.

SD-09 Reports

Tests, Inspections, and Verifications; FIO.

Certified test reports for materials shall be submitted with all materials delivered to the site.

SD-13 Certificates

Qualification of Welders and Welding Operators; FIO.

Certifications for welders and welding operators shall be submitted prior to commencing fabrication.

Application Qualification for Steel Studs; GA.

Certified reports for the application qualification for steel studs shall be submitted and approved prior to commencing fabrication.

Welding of Aluminum; GA.

Certified report for aluminum welding qualification tests shall be submitted and approved prior to commencing welding.

SD-18 Records

Materials Disposition Records; FIO.

Materials disposition records shall be submitted before completion of contract.

1.3 METALWORK AND MACHINE WORK DETAIL DRAWINGS

Detail drawings for metalwork and machine work shall include catalog cuts, templates, fabrication and assembly details and type, grade and class of material as appropriate. Elements of fabricated items inadvertently omitted on contract drawings shall be detailed by the fabricator and indicated on the detail drawings.

1.4 QUALIFICATION OF WELDERS AND WELDING OPERATORS

The Contractor shall certify that the qualification of welders and welding operators and tack welders who will perform structural steel welding have been qualified for the particular type of work to be done in accordance with the requirements of AWS D1.1, Section 5 or ASME BPV IX, Section IX, prior to commencing fabrication. The certificate shall list the qualified welders by name and shall specify the code and procedures under which qualified and the date of qualification. Prior qualification will be accepted if welders have performed satisfactory work under the code for which qualified within the

preceding three months. The Contractor shall require welders to repeat the qualifying tests when their work indicates a reasonable doubt as to proficiency. Those passing the requalification tests will be recertified. Those not passing will be disqualified until passing. All expenses in connection with qualification and requalification shall be borne by the Contractor.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Materials Orders

The Contractor shall furnish 4 copies of purchase orders, mill orders, shop orders and work orders for all materials orders and items used in the work. Where mill tests are required purchase orders shall contain the test site address and the name of the testing agency.

2.1.2 Materials List

The Contractor shall furnish a materials list of the materials to be used in the fabrication of each item.

2.1.3 Shipping Bill

The Contractor shall furnish a shipping bill or memorandum of each shipment of finished pieces or members to the project site giving the designation mark and weight of each item, the number of items, the total weight, and the car initial and number if shipped by rail in carload lots. Duplicate copies of shipping bills shall be mailed promptly to Contracting Officer.

2.2 FABRICATION

2.2.1 Structural Fabrication

Material must be straight before being laid off or worked. If straightening is necessary it shall be done by methods that will not impair the metal. Sharp kinks or bends shall be cause for rejection of the material. Material with welds will not be accepted except where welding is definitely specified, indicated or otherwise approved. Bends shall be made by approved dies, press brakes or bending rolls. Where heating is required, precautions shall be taken to avoid overheating the metal and it shall be allowed to cool in a manner that will not impair the original properties of the metal. Proposed flame cutting of material other than structural steel shall be subject to approval and shall be indicated on detail drawings. Shearing shall be accurate and all portions of the work shall be neatly finished. Corners shall be square and true unless otherwise shown. Re-entrant cuts shall be filleted to a minimum radius of 3/4 inch unless otherwise approved. Finished members shall be free of twists, bends and open joints. Bolts, nuts and screws shall be tight.

2.2.1.1 Dimensional Tolerances for Structural Work

Dimensions shall be measured by an approved calibrated steel tape of approximately the same temperature as the material being measured. The overall dimensions of an assembled structural unit shall be within the tolerances indicated on the drawings or as specified in the particular section of these specifications for the item of work. Where tolerances are not specified in other sections of these specifications or shown, an allowable variation of 1/32 inch is permissible in the overall length of component members with both ends milled and component members without milled ends shall not

deviate from the dimensions shown by more than 1/16 inch for members 30 feet or less in length and by more than 1/8 inch for members over 30 feet in length.

2.2.1.2 Structural Steel Fabrication

Structural steel may be cut by mechanically guided or hand-guided torches, provided an accurate profile with a surface that is smooth and free from cracks and notches is obtained. Surfaces and edges to be welded shall be prepared in accordance with AWS D1.1, Subsection 3.2. Where structural steel is not to be welded, chipping or grinding will not be required except as necessary to remove slag and sharp edges of mechanically guided or hand-guided cuts not exposed to view. Hand-guided cuts which are to be exposed or visible shall be chipped, ground or machined to sound metal.

2.2.2 Welding

2.2.2.1 Welding of Structural Steel

- a. **Welding Procedures for Structural Steel** - Welding procedures for structural steel shall be prequalified as described in AWS D1.1, Subsection 5.1 or shall be qualified by tests as prescribed in AWS D1.1, Section 5. Properly documented evidence of compliance with all requirements of these specifications for previous qualification tests shall establish a welding procedure as prequalified. For welding procedures qualified by tests, the test welding and specimen testing must be witnessed and the test report document signed by the Contracting Officer. Approval of any welding procedure will not relieve the Contractor of the responsibility for producing a finished structure meeting all requirements of these specifications. The Contractor will be directed or authorized to make any changes in previously approved welding procedures that are deemed necessary or desirable by the Contractor Officer. The Contractor shall submit a complete schedule of welding procedures for each steel structure to be welded. The schedule shall conform to the requirements specified in the provisions AWS D1.1, Sections 2, 3, 4, 7 and 9 and applicable provisions of Section 10. The schedule shall provide detailed procedure specifications and tables or diagrams showing the procedures to be used for each required joint. Welding procedures must include filler metal, preheat, interpass temperature and stress-relief heat treatment requirements. Each welding procedure shall be clearly identified as being prequalified or required to be qualified by tests. Welding procedures must show types and locations of welds designated or in the specifications to receive nondestructive examination.
- b. **Welding Process** - Welding of structural steel shall be by an electric arc welding process using a method which excludes the atmosphere from the molten metal and shall conform to the applicable provisions of AWS D1.1, Sections 1 thru 7, 9, 10 and 11. Welding shall be such as to minimize residual stresses, distortion and shrinkage.
- c. **Welding Technique**
 - (1) **Filler Metal** - The electrode, electrode-flux combination and grade of weld metal shall conform to the appropriate AWS specification for the base metal and welding process being used or shall be as shown where a specific choice of AWS specification allowables is required. The AWS designation of the electrodes to be used shall be included in the schedule of welding procedures. Only low hydrogen electrodes shall be used for manual shielded metal-arc welding regardless of the thickness of the steel. A controlled temperature storage oven shall be used at the job

site as prescribed by AWS D1.1, Subsection 4.5 to maintain low moisture of low hydrogen electrodes.

- (2) Preheat and Interpass Temperature - Preheating shall be performed as required by AWS D1.1, Subsection 4.2 and 4.3 or as otherwise specified except that the temperature of the base metal shall be at least 70 degrees F. The weldments to be preheated shall be slowly and uniformly heated by approved means to the prescribed temperature, held at that temperature until the welding is completed and then permitted to cool slowly in still air.
 - (3) Stress-Relief Heat Treatment - Where stress relief heat treatment is specified or shown, it shall be in accordance with the requirements of AWS D1.1, Subsection 4.4 unless otherwise authorized or directed.
- d. Workmanship - Workmanship for welding shall be in accordance with AWS D1.1, Section 3 and other applicable requirements of these specifications.
- (1) Preparation of Base Metal - Prior to welding the Contractor shall inspect surfaces to be welded to assure compliance with AWS D1.1, Subsection 3.2.
 - (2) Temporary Welds - Temporary welds required for fabrication and erection shall be made under the controlled conditions prescribed for permanent work. Temporary welds shall be made using low-hydrogen welding electrodes and by welders qualified for permanent work as specified in these specifications. Preheating for temporary welds shall be as required by AWS D1.1 for permanent welds except that the minimum temperature shall be 120 degrees F in any case. In making temporary welds arcs shall not be struck in other than weld locations. Each temporary weld shall be removed and ground flush with adjacent surfaces after serving its purpose.
 - (3) Tack Welds - Tack welds that are to be incorporated into the permanent work shall be subject to the same quality requirements as the permanent welds and shall be cleaned and thoroughly fused with permanent welds. Preheating shall be performed as specified above for temporary welds. Multiple-pass tack welds shall have cascaded ends. Defective tack welds shall be removed before permanent welding.

2.2.2.2 Welding of Steel Castings

Unsound material shall be removed from the surfaces of steel castings to be incorporated into welded connections by chipping, machining, air-arc gouging or grinding. Major connections designed for transfer of stresses shall not be welded if the temperature of the casting is lower than 100 degrees F. Castings containing over 0.35 percent carbon or over 0.75 percent manganese shall be preheated to a temperature not to exceed 450 degrees F and welding shall be accomplished while the castings are maintained at a temperature above 350 degrees F. Welding will not be permitted on castings containing carbon in excess of 0.45 percent except on written authorization. Castings requiring welding repairs after the first annealing and castings involving welding fabrication shall be stress-relieved annealed prior to receiving final machining unless otherwise permitted.

2.2.2.3 Welding of Steel Studs

The procedures for welding steel studs to structural steel, including mechanical, workmanship, technique, stud application qualification, production quality control and fabrication and verification

inspection procedures shall conform to the requirements of AWS D1.1, Section 7, except as otherwise specified.

- a. Application Qualification for Steel Studs - As a condition of approval of the stud application process, the Contractor shall furnish certified test reports and certification that the studs conform to the requirements of AWS D1.1, Subsections 7.2 and 7.3, certified results of the stud manufacturer's stud base qualification test, and certified results of the stud application qualification test as required by AWS D1.1, Subsection 7.6, except as otherwise specified.
- b. Production Quality Control - Quality control for production welding of studs shall conform to the requirements of AWS D1.1, Subsection 7.7, except as otherwise specified. Studs on which pre-production testing is to be performed shall be welded in the same general position as required on production studs (flat, vertical, overhead or sloping). If the reduction of the length of studs becomes less than normal as they are welded, welding shall be stopped immediately and not resumed until the cause has been corrected.

2.2.3 Bolted Connections

2.2.3.1 Bolted Structural Steel Connections

Bolts, nuts and washers shall be of the type specified or indicated. All nuts shall be equipped with washers except for high strength bolts. Beveled washers shall be used where bearing faces have a slope of more than 1:20 with respect to a plane normal to the bolt axis. Where the use of high strength bolts is specified or indicated the materials, workmanship and installation shall conform to the applicable provisions of ASTM A 325 or ASTM A 490.

- a. Bolt Holes - Bolt holes shall be accurately located, smooth, perpendicular to the member and cylindrical.
 - (1) Holes for regular bolts shall be drilled or subdrilled and reamed in the shop and shall not be more than 1/16 inch larger than the diameter of the bolt.
 - (2) Holes for fitted bolts shall be match-reamed or drilled in the shop. Burrs resulting from reaming shall be removed. The threads of bolts shall be entirely outside of the holes. The body diameter of bolts shall have tolerances as recommended by ASME B4.1 for the class of fit specified. Fitted bolts shall be fitted in reamed holes by selective assembly to provide an LN-2 fit.
 - (3) Holes for high strength bolts shall have diameters of not more than 1/16 inch larger than bolt diameters. If the thickness of the material is not greater than the diameter of the bolts the holes may be punched. If the thickness of the material is greater than the diameter of the bolts the holes may be drilled full size or subpunched or subdrilled at least 1/8 inch smaller than the diameter of the bolts and then reamed to full size. Poor matching of holes will be cause for rejection. Drifting occurring during assembly shall not distort the metal or enlarge the holes. Reaming to a larger diameter of the next standard size bolt will be allowed for slight mismatching.

2.2.4 Patterns

Care shall be taken to avoid sharp corners or abrupt changes in cross section and ample fillets shall be used in the construction of patterns. Draft and increases in pattern thicknesses shall be added as required to conform to the standard foundry practice applied and as necessary to ensure that all metal thicknesses of the finished castings conform to the dimensions shown. All patterns shall remain the property of the Contractor.

2.2.5 Castings

Each casting shall bear cast or stamped mark numbers. Castings weighing more than 500 required pounds shall also bear cast or stamped heat numbers. Deviations from the dimensions of castings shown shall not exceed amounts that will impair the strength of castings by more than 10 percent as computed from the dimensions shown. Dimensions of castings shown on approved detail drawings shall be finished dimensions. Castings that are warped or otherwise distorted or that are oversize to an extent that will interfere with proper fit with other parts of the machinery or structure will be rejected. The structure of metal in castings shall be homogeneous and free from excessive nonmetallic inclusions. Excessive segregation of impurities or alloys at critical points in castings will be cause for rejection. Repairs to castings shall not be made prior to approval. Minor surface imperfections not affecting the strength of casting may be welded in the "green" if approved. Surface imperfections shall be considered minor when the depth of the cavity prepared for welding is the lesser of 20 percent of the actual wall thickness or 1 inch. Defects other than minor surface imperfections may be welded only when specifically authorized in accordance with the following requirements:

- a. The defects have been entirely removed and are judged not to affect the strength, use or machineability of the castings when properly welded and stress relieved.
- b. The proposed welding procedure, stress relief and method of examination of the repair work have been submitted and approved.

2.2.6 Machine Work

Tolerances, allowances and gauges for metal fits between plain, non-threaded, cylindrical parts shall conform to ASME B4.1 for the class of fit shown or required unless otherwise shown on approved detail drawings. Where fits are not shown they shall be suitable as approved. Tolerances for machine-finished surfaces designated by non-decimal dimensions shall be within 1/64 inch. Sufficient machining stock shall be allowed on placing pads to ensure true surfaces of solid material. Finished contact or bearing surfaces shall be true and exact to secure full contact. Journal surfaces shall be polished and all surfaces shall be finished with sufficient smoothness and accuracy to ensure proper operation when assembled. Parts entering any machine shall be accurately machined and all like parts shall be interchangeable except that parts assembled together for drilling or reaming of holes or machining will not be required to be interchangeable with like parts. All drilled bolt holes shall be accurately located.

2.2.6.1 Finished Surfaces

Surface finishes indicated or specified shall be in accordance with ASME B46.1. Values of required roughness heights are arithmetical average deviations expressed in microinches. These values are maximum. Lesser degrees will be satisfactory unless otherwise indicated. Compliance with surface requirements shall be determined by sense of feel and visual inspection of the work compared to Roughness Comparison Specimens in accordance with the provisions of ASME B46.1. Values of

roughness width and waviness height shall be consistent with the general type of finish specified by roughness height. Where the finish is not indicated or specified it shall be that which is most suitable for the particular surface, provide the class of fit required and be indicated on the detail drawings by a symbol which conforms to ASME B46.1 when machine finishing is provided. Flaws such as scratches, ridges, holes, peaks, cracks or checks which will make the part unsuitable for the intended use will be cause for rejection.

2.2.6.2 Unfinished Surfaces

All work shall be laid out to secure proper matching of adjoining unfinished surfaces unless otherwise directed. Where there is a large discrepancy between adjoining unfinished surfaces they shall be chipped and ground smooth or machined to secure proper alignment. Unfinished surfaces shall be true to the lines and dimensions shown and shall be chipped or ground free of all projections and rough spots. Depressions or holes not affecting the strength or usefulness of the parts shall be filled in an approved manner.

2.2.6.3 Pin Holes

Pin holes shall be bored true to gauges, smooth, straight and at right angles to the axis of the member. The boring shall be done after the member is securely fastened in position.

2.2.6.4 Gears

Gears shall have machine cut teeth of a form conforming to applicable design requirements of AGMA 2005-C and AGMA 6001-D unless otherwise specified or shown.

2.2.6.5 Shafting

All shafting shall be turned or ground hot-rolled or cold-rolled steel as required unless otherwise specified or authorized. Fillets shall be provided where changes in section occur. Cold-finished shafting may be used where keyseating is the only machine work required.

2.2.6.6 Bearings

Bearings may be lined with babbitt or bronze unless otherwise specified or shown. Where the bearing pressure is in excess of 200 psi, bearings shall be lined with bronze. Pressures on lined bearings shall not exceed 400 psi of projected area unless otherwise required or authorized. Anti-friction bearings of approved types and of sizes not less than those recommended by the bearing manufacturer for the duty intended will be permitted subject to approval. All bearings shall be properly aligned and provided with a suitable means of lubrication. Anti-friction bearings shall be so installed as to provide for retention of the lubricant and to exclude dirt and grit.

2.2.7 Miscellaneous Provisions

2.2.7.1 Metallic Coatings

- a. Zinc Coatings - Zinc coatings shall be applied in a manner and of a thickness and quality conforming to ASTM A 123. Where zinc coatings are destroyed by cutting, welding or other causes the affected areas shall be regalvanized. Coatings 2 ounces or heavier shall be regalvanized with a suitable low-melting zinc base alloy similar to the recommendations of the American Hot-Dip Galvanizers Association to the thickness and quality specified for

the original zinc coating. Coatings less than 2 ounces shall be repaired in accordance with ASTM A 780.

- b. Cadmium Coatings - Cadmium coatings shall be of a quality and thickness conforming to the requirements of ASTM B 766 and inspection shall conform to the requirements of ASTM E 165.
- c. Chromium Coatings - Chromium coatings for engineering use shall be applied in conformity with ASTM B 177.

2.2.7.2 Cleaning of Corrosion-Resisting Steel

Oil, paint and other foreign substances shall be removed from corrosion-resisting steel surfaces after fabrication. Cleaning shall be done by vapor degreasing or by the use of cleaners of the alkaline, emulsion or solvent type. After the surfaces have been cleaned they shall be given a final rinsing with clean water followed by a 24 hour period during which the surfaces are intermittently wet with clean water and then allowed to dry for the purpose of inspecting the clean surfaces. The surfaces shall be visually inspected for evidence of paint, oil, grease, welding slag, heat treatment scale, iron rust or other forms of contamination. If evidence of foreign substance exists the surface shall be cleaned in accordance with the applicable provisions of ASTM A 380. The proposed method of treatment shall be furnished for approval. After treatment the surfaces shall be visually reinspected. Brushes used to remove foreign substances shall have only stainless steel or nonmetallic bristles. Any contamination occurring subsequent to the initial cleaning shall be removed by one or more of the methods indicated above.

2.2.7.3 Lubrication

The arrangement and details for lubrication shall be as shown. Before erection or assembly all bearing surfaces shall be thoroughly cleaned and lubricated with an approved lubricant.

2.2.8 Shop Assembly

Each machinery and structural unit furnished shall be assembled in the shop to determine the correctness of the fabrication and matching of the component parts unless otherwise specified. Tolerances shall not exceed those shown. Each unit assembled shall be closely checked to ensure that all necessary clearances have been provided and that binding does not occur in any moving part. Assembly in the shop shall be in the same position as final installation in the field unless otherwise specified. Assembly and disassembly work shall be performed in the presence of the Contracting Officer unless waived in writing. Errors or defects disclosed shall be immediately remedied by the Contractor without cost to the Government. Before disassembly for shipment each piece of a machinery or structural unit shall be match-marked to facilitate erection in the field. The location of match-marks shall be indicated by circling with a ring of white paint after the shop coat of paint has been applied or as otherwise directed.

2.3 TESTS, INSPECTIONS, AND VERIFICATIONS

The Contractor shall have required material tests and analyses performed and certified by an approved laboratory to demonstrate that materials are in conformity with the specifications. These tests and analyses shall be performed and certified at the Contractor's expense. Tests, inspections, and verifications shall conform to the requirements of the particular sections of these specifications for the respective items of work unless otherwise specified or authorized. Tests shall be conducted in the

presence of the Contracting Officer if so required. The Contractor shall furnish specimens and samples for additional independent tests and analyses upon request by the Contracting Officer. Specimens and samples shall be properly labeled and prepared for shipment.

2.3.1 Nondestructive Testing

When doubt exists as to the soundness of any material part such part may be subjected to any form of nondestructive testing determined by the Contracting Officer. This may include ultrasonic, magnaflux, dye penetrant, x-ray, gamma ray or any other test that will thoroughly investigate the part in question. The cost of such investigation will be borne by the Government. Any defects will be cause for rejection and rejected parts shall be replaced and retested at the Contractor's expense.

2.3.2 Tests of Machinery and Structural Units

The details for tests of machinery and structural units shall conform to the requirements of the particular sections of these specifications covering these items. Each complete machinery and structural unit shall be assembled and tested in the shop in the presence of the Contracting Officer unless otherwise directed. Waiving of tests will not relieve the Contractor of responsibility for any fault in operation, workmanship or material that occurs before the completion of the contract or guarantee. After being installed at the site each complete machinery or structural unit shall be operated through a sufficient number of complete cycles to demonstrate to the satisfaction of the Contracting Officer that it meets the specified operational requirements in all respects.

2.3.3 Inspection of Structural Steel Welding

The Contractor shall maintain an approved inspection system and perform required inspections in accordance with Contract Clause CONTRACTOR INSPECTION SYSTEM. Welding shall be subject to inspection to determine conformance with the requirements of AWS D1.1, the approved welding procedures and provisions stated in other sections of these specifications. Nondestructive examination of designated welds will be required. Supplemental examination of any joint or coupon cut from any location in any joint may be required.

2.3.3.1 Visual Examination

All visual examination of completed welds shall be cleaned and carefully examined for insufficient throat or leg sizes, cracks, undercutting, overlap, excessive convexity or reinforcement and other surface defects to ensure compliance with the requirements of AWS D1.1, Section 3 and Section 9, Part D.

2.3.3.2 Nondestructive Examination

The nondestructive examination of shop and field welds shall be performed as designated or described in the sections of these specifications covering the particular items of work.

- a. Testing Agency - The nondestructive examination of welds and the evaluation of examination tests as to the acceptability of the welds shall be performed by a testing agency adequately equipped and competent to perform such services or by the Contractor using suitable equipment and qualified personnel. In either case written approval of the examination procedures is required and the examination tests shall be made in the presence of the Contracting Officer. The evaluation of examination tests shall be subject to the approval and all records shall become the property of the Government.

- b. Examination Procedures - Examination procedures shall conform to the following requirements.
 - (1) Ultrasonic Testing - Making, evaluating and reporting ultrasonic testing of welds shall conform to the requirements of AWS D1.1, Section 6, Part C. The ultrasonic equipment shall be capable of making a permanent record of the test indications. A record shall be made of each weld tested.
 - (2) Radiographic Testing - Making, evaluating and reporting radiographic testing of welds shall conform to the requirements of AWS D1.1, Section 6, Part B.
 - (3) Magnetic Particle Inspection - Magnetic particle inspection of welds shall conform to the applicable provisions of ASTM E 709.
 - (4) Dye Penetrant Inspection - Dye penetrant inspection of welds shall conform to the applicable provisions of ASTM E 165.
- c. Acceptability of Welds - Welds shall be unacceptable if shown to have defects prohibited by AWS D1.1, Subsection 9.25 or possess any degree of incomplete fusion, inadequate penetration or undercutting.

2.3.3.3 Test Coupons

The Government reserves the right to require the Contractor to remove coupons from completed work when doubt as to soundness cannot be resolved by nondestructive examination. Should tests of any two coupons cut from the work of any welder show strengths less than that specified for the base metal it will be considered evidence of negligence or incompetence and such welder shall be removed from the work. When coupons are removed from any part of a structure the members cut shall be repaired in a neat manner with joints of the proper type to develop the full strength of the members. Repaired joints shall be peened as approved or directed to relieve residual stress. The expense for removing and testing coupons, repairing cut members and the nondestructive examination of repairs shall be borne by the Government or the Contractor in accordance with the Contract Clauses INSPECTION AND ACCEPTANCE.

2.3.3.4 Supplemental Examination

When the soundness of any weld is suspected of being deficient due to faulty welding or stresses that might occur during shipment or erection the Government reserves the right to perform nondestructive supplemental examinations before final acceptance. The cost of such inspection will be borne by the Government.

2.3.4 Structural Steel Welding Repairs

Defective welds in the structural steel welding repairs shall be repaired in accordance with AWS D1.1, Subsection 3.7. Defective weld metal shall be removed to sound metal by use of air carbon-arc or oxygen gouging. Oxygen gouging shall not be used on ASTM A 514/A 514M steel. The surfaces shall be thoroughly cleaned before welding. Welds that have been repaired shall be retested by the same methods used in the original inspection. Except for the repair of members cut to remove test coupons and found to have acceptable welds costs of repairs and retesting shall be borne by the Contractor.

2.3.5 Inspection and Testing of Steel Stud Welding

Fabrication and verification inspection and testing of steel stud welding shall conform to the requirements of AWS D1.1, Subsection 7.8 except as otherwise specified. The Contracting Officer will serve as the verification inspector. One stud in every 100 and studs that do not show a full 360 degree weld flash, have been repaired by welding or whose reduction in length due to welding is less than normal shall be bent or torque tested as required by AWS D1.1, Subsection 7.8. If any of these studs fail two additional studs shall be bent or torque tested. If either of the two additional studs fail all of the studs represented by the tests shall be rejected. Studs that crack under testing in either the weld, base metal or shank shall be rejected and replaced by the Contractor at no additional cost.

PART 3 EXECUTION

3.1 INSTALLATION

All parts to be installed shall be thoroughly cleaned. Packing compounds, rust, dirt, grit and other foreign matter shall be removed. Holes and grooves for lubrication shall be cleaned. Enclosed chambers or passages shall be examined to make sure that they are free from damaging materials. Where units or items are shipped as assemblies they will be inspected prior to installation. Disassembly, cleaning and lubrication will not be required except where necessary to place the assembly in a clean and properly lubricated condition. Pipe wrenches, cold chisels or other tools likely to cause damage to the surfaces of rods, nuts or other parts shall not be used for assembling and tightening parts. Bolts and screws shall be tightened firmly and uniformly but care shall be taken not to overstress the threads. When a half nut is used for locking a full nut the half nut shall be placed first and followed by the full nut. Threads of all bolts except high strength bolts, nuts and screws shall be lubricated with an approved lubricant before assembly. Threads of corrosion-resisting steel bolts and nuts shall be coated with an approved antigalling compound. Driving and drifting bolts or keys will not be permitted.

3.1.1 Alignment and Setting

Each machinery or structural unit shall be accurately aligned by the use of steel shims or other approved methods so that no binding in any moving parts or distortion of any member occurs before it is fastened in place. The alignment of all parts with respect to each other shall be true within the respective tolerances required. Machines shall be set true to the elevations shown.

3.1.2 Blocking and Wedges

All blocking and wedges used during installation for the support of parts to be grouted in foundations shall be removed before final grouting unless otherwise directed. Blocking and wedges left in the foundations with approval shall be of steel or iron.

3.1.3 Foundations and Grouting

Concreting of subbases and frames and the final grouting under parts of machines shall be in accordance with the procedures as specified in Section 03301 CAST-IN-PLACE STRUCTURAL CONCRETE.

3.2 PROTECTION OF FINISHED WORK

3.2.1 Machined Surfaces

Machined surfaces shall be thoroughly cleaned of foreign matter. All finished surfaces shall be protected by suitable means. Unassembled pins and bolts shall be oiled and wrapped with moisture resistant paper or protected by other approved means. Finished surfaces of ferrous metals to be in bolted contact shall be washed with an approved rust inhibitor and coated with an approved rust resisting compound for temporary protection during fabrication, shipping and storage periods. Finished surfaces of metals which shall be exposed after installation except corrosion resisting steel or nonferrous metals shall be painted as specified in Section 09940 PAINTING: HYDRAULIC STRUCTURES.

3.2.2 Lubrication After Assembly

After assembly all lubricating systems shall be filled with the lubricant specified and additional lubricant shall be applied at intervals as required to maintain the equipment in satisfactory condition until acceptance of the work.

3.3 TESTS

3.3.1 Workmanship

Workmanship shall be of the highest grade and in accordance with the best modern practices to conform with the specifications for the item of work being furnished.

3.3.2 Production Welding

Production welding shall conform to the requirements of AWS D1.1 or AWS D1.2 as applicable. Studs on which pre-production testing is to be performed shall be welded in the same general position as required on production items (flat, vertical, overhead or sloping). Test and production stud welding will be subjected to visual examination or inspection. If the reduction of the length of studs becomes less than normal as they are welded, welding shall be stopped immediately and not resumed until the cause has been corrected.

End of Section

DIVISION 5 - METALS

SECTION 05120

STRUCTURAL STEEL

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SECTION 05120

STRUCTURAL STEEL

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC S335	(1989) Specification for Structural Steel Buildings - Allowable Stress Design and Plastic Design
AISC S303	(1992) Code of Standard Practice for Steel Buildings and Bridges
AISC S329	(R1994) Allowable Stress Design Specification for Structural Joints Using ASTM A325 or ASTM A490 Bolts

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 6	(1997) General Requirements for Rolled Structural Bars, Plates, Shapes, and Sheet Piling
ASTM A 36	(1996) Carbon Structural Steel
ASTM A 53	(1997) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A 307	(1994) Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM A 325	(1997) Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A 500	(1996) Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A 563	(1996) Carbon and Alloy Steel Nuts
ASTM F 844	(1990) Washers, Steel, Plain (Flat), Unhardened for General Use

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B46.1 (1995) Surface Texture (Surface Roughness, Waviness and Lay)

AMERICAN WELDING SOCIETY (AWS)

AWS A2.4 (1998) Standard Symbols for Welding, Brazing and Nondestructive Examination

AWS D1.1 (1998) Structural Welding Code - Steel

STEEL STRUCTURES PAINTING COUNCIL (SSPC)

SSPC Paint 25 (1991) Red Iron Oxide, Zinc Oxide, Raw Linseed Oil and Alkyd Primer (without Lead and Chromate Pigments)

1.2 GENERAL REQUIREMENTS

Structural steel fabrication and erection shall be performed by an organization experienced in structural steel work of equivalent magnitude. The Contractor shall be responsible for correctness of detailing, fabrication, and for the correct fitting of structural members. Connections, for any part of the structure not shown on the contract drawings, shall be considered simple shear connections and shall be designed and detailed in accordance with pertinent provisions of AISC S329. Substitution of sections or modification of connection details will not be accepted unless approved by the Contracting Officer. AISC S335 shall govern the work. Welding shall be in accordance with AWS D1.1. High-strength bolting shall be in accordance with AISC S329.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-04 Drawings

Structural Steel System; GA. Structural Connections; GA.

Shop and erection details including members, with their connections, not shown on the contract drawings. Welds shall be indicated by standard welding symbols in accordance with AWS A2.4.

SD-08 Statements

Erection; FIO.

Erection plan of the structural steel framing required. Erection plan shall conform to the requirements of AISC S303, shall be submitted prior to erection, and shall describe all necessary temporary supports, including the sequence of installation and removal.

SD-13 Certificates

Mill Test Reports; FIO.

Certified copies of mill test reports for structural steel, structural bolts, nuts, washers and other related structural steel items.

Welder Qualifications; FIO.

Certified copies of welder qualifications test records showing qualification in accordance with AWS D1.1.

Fabrication; FIO.

A copy of the AISC certificate indicating that the fabrication plant meets the specified structural steelwork category.

SD-14 Samples

High Strength Bolts and Nuts; FIO. Carbon Steel Bolts and Nuts; FIO. Nuts Dimensional Style; FIO. Washers; FIO.

Random samples of bolts, nuts, and washers as delivered to the job site if requested, taken in the presence of the Contracting Officer and provided to the Contracting Officer for testing to establish compliance with specified requirements.

1.4 STORAGE

Material shall be stored out of contact with the ground in such manner and location as will minimize deterioration.

PART 2 PRODUCTS

2.1 STRUCTURAL STEEL

2.1.1 Carbon Grade Steel

Carbon grade steel shall conform to ASTM A 36.

2.2 STRUCTURAL TUBING

Structural tubing shall conform to ASTM A 500, Grade 42.

2.3 STEEL PIPE

Steel pipe shall conform to ASTM A 53, Type E, Grade B.

2.4 HIGH STRENGTH BOLTS AND NUTS

High strength bolts shall conform to ASTM A 325, Type 1 with carbon steel nuts conforming to ASTM A 563, Grade C DH.

2.5 CARBON STEEL BOLTS

Carbon steel bolts shall conform to ASTM A 307, Grade A with carbon steel nuts conforming to ASTM A 563, Grade A.

2.6 NUTS DIMENSIONAL STYLE

Carbon steel nuts shall be Heavy Hex Style when used with ASTM A 307 bolts or Heavy Hex style when used with ASTM A 325 bolts.

2.7 WASHERS

Plain washers shall conform to ASTM F 844.

2.8 PAINT

Paint shall conform to SSPC Paint 25.

PART 3 EXECUTION

3.1 FABRICATION

Fabrication shall be in accordance with the applicable provisions of AISC S335. Fabrication and assembly shall be done in the shop to the greatest extent possible. The fabricating plant shall be certified under the AISC quality certification program for Category I structural steelwork. Compression joints depending on contact bearing shall have a surface roughness not in excess of 500 micro inches as determined by ASME B46.1, and ends shall be square within the tolerances for milled ends specified in ASTM A 6. Structural steelwork, except surfaces of steel to be encased in concrete, surfaces to be field welded shall be prepared for painting in accordance with the AISC S335 and primed with the specified paint.

3.2 ERECTION

Erection of structural steel shall be in accordance with the applicable provisions of AISC S335.

3.2.1 Connections

Anchor bolts and other connections between the structural steel and foundations shall be provided and shall be properly located and built into connecting work. Steel on steel connections are to be bearing type with threads in the shear plane.

3.2.2 Base Plates and Bearing Plates

Column base plates for columns and bearing plates for beams, girders, and similar members shall be provided. Base plates and bearing plates shall be provided with full bearing after the supported members have been plumbed and properly positioned, but prior to placing superimposed loads. Separate setting plates under column base plates will not be permitted. The area under the plate shall be damp-packed solidly with bedding mortar, except where nonshrink grout is indicated on the drawings. Bedding mortar and grout shall be as specified in Section 03301 CAST-IN-PLACE STRUCTURAL CONCRETE.

3.2.3 Field Welded Connections

Field welded structural connections shall be completed before load is applied.

3.2.4 Field Priming

After erection, the field bolt heads and nuts, field welds, and any abrasions in the shop coat shall be cleaned and primed with paint of the same quality as that used for the shop coat.

3.3 FINISH PAINTING

All structural steel items will receive a finish paint as specified in Section 09900 PAINTING, GENERAL.

End of Section

DIVISION 5 - METALS

SECTION 05210

STEEL JOISTS

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SECTION 05210

STEEL JOISTS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

STEEL JOIST INSTITUTE (SJI)

SJI-01	(1994) Standard Specifications Load Tables and Weight Tables for Steel Joists and Joist Girders
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1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-04 Drawings

Steel Joists; GA.

Detail drawings shall include fabrication and erection details, specifications for shop painting, and identification markings of joists.

SD-13 Certificates

Steel Joists; FIO.

Certificates stating that the steel joists have been designed and manufactured in accordance with SJI-01. Complete engineering design computations may be submitted in lieu of the certification.

1.3 DESCRIPTION

Steel joists are designated on the drawings in accordance with the standard designations of the Steel Joist Institute. Joists of other standard designations or joists with properties other than those shown may be substituted for the joists designated provided the structural properties are equal to or greater than those of the joists shown and provided all other specified requirements are met.

1.4 DELIVERY AND STORAGE

Materials shall be delivered to the site in undamaged condition and stored off the ground in a well drained location, protected from damage, and easily accessible for inspection and handling.

PART 2 PRODUCTS

2.1 OPEN WEB STEEL JOISTS

Open web steel joists shall conform to SJI-01, K-Series. Joists shall be designed to support the loads given in the standard load tables of SJI-01.

2.2 ACCESSORIES AND FITTINGS

Accessories and fittings, including end supports and bridging, shall be in accordance with the standard specifications under which the members were designed.

2.3 SHOP PAINTING

Joists and accessories shall be shop painted with a rust-inhibiting primer paint. For joists which will be finish painted under Section 09900 PAINTING, GENERAL, the primer paint shall be limited to a primer which is compatible with the specified finish paint.

PART 3 EXECUTION

3.1 ERECTION

Installation of joists shall be in accordance with the standard specification under which the member was produced. Joists shall be handled in a manner to avoid damage. Damaged joists shall be removed from the site, except when field repair is approved and such repairs are satisfactorily made in accordance with the manufacturer's recommendations. Joists shall be accurately set, and end anchorage shall be in accordance with the standard specification under which the joists were produced. Joist bridging and anchoring shall be secured in place prior to the application of any construction loads. Any temporary loads shall be distributed so that the carrying capacity of any joist is not exceeded. Loads shall not be applied to bridging during construction or in the completed work. Abraded, corroded, and field welded areas shall be cleaned and touched up with the same type of paint used in the shop painting.

3.2 BEARING PLATES

Bearing plates shall be provided with full bearing after the supporting members have been plumbed and properly positioned, but prior to placing superimposed loads. The area under the plate shall be damp-packed solidly with bedding mortar, except where nonshrink grout is indicated on the drawings. Bedding mortar and grout shall be as specified in Section 03301 CAST-IN-PLACE STRUCTURAL CONCRETE.

End of Section

DIVISION 5 - METALS

SECTION 05300

STEEL DECKING

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SECTION 05300

STEEL DECKING

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISI-01 (Varies) Cold-Formed Steel Design Manual

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 611 (1997) Steel, Sheet, Carbon, Cold-Rolled, Structural Quality

ASTM A 653 (1997) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy coated (Galvannealed) by the Hot-Dip Process

ASTM A 780 (1993a) Repair of Damaged and Uncoated Areas of Hot-Dipped Galvanized Coatings

AMERICAN WELDING SOCIETY (AWS)

AWS D1.3 (1998) Structural Welding Code - Sheet Steel

STEEL DECK INSTITUTE (SDI)

SDI-02 (1987; Amended 1991) Diaphragm Design Manual

SDI Pub No 28 (1995) Design Manual for Composite Decks, Form Decks, Roof Decks, and Cellular Metal Floor Deck with Electrical Distribution

STEEL STRUCTURES PAINTING COUNCIL (SSPC)

SSPC Paint 20 (1991) Zinc-Rich Primers (Type I - Inorganic and Type II - Organic)

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Deck Units; GA.

Design computations for the structural properties of the deck units or SDI certification that the units are designed in accordance with SDI specifications.

SD-04 Drawings

Deck Units; GA. Accessories; GA.
Attachments; GA. Holes and Openings; GA.

Drawings shall include type, configuration, structural properties, location, and necessary details of deck units, accessories, and supporting members; size and location of holes to be cut and reinforcement to be provided; location and sequence of welded or fastener connections; and the manufacturer's erection instructions.

SD-13 Certificates

Deck Units; FIO. Attachments; FIO.

Manufacturer's certificates attesting that the decking material meets the specified requirements.
Manufacturer's certificate attesting that the operators are authorized to use the low-velocity piston tool.

SD-18 Statements

Attachments; FIO.

Prior to welding operations, copies of qualified procedures and lists of names and identification symbols of qualified welders and welding operators.

1.3 DELIVERY, STORAGE, AND HANDLING

Deck units shall be delivered to the site in a dry and undamaged condition, stored off the ground with one end elevated, and stored under a weathertight covering permitting good air circulation. Finish of deck units shall be maintained at all times by using touch-up paint whenever necessary to prevent the formation of rust.

PART 2 PRODUCTS

2.1 DECK UNITS

Deck units shall conform to SDI Pub No 28. Panels of maximum possible lengths shall be used to minimize end laps. Fabricate deck units in lengths to span 3 or more supports with flush, telescoped, or nested 2 inch laps at ends, and interlocking, or nested side laps, unless otherwise indicated. Deck with cross-sectional configuration differing from the units indicated may be used, provided that the properties of the proposed units, determined in accordance with AISI-01, are equal to or greater than the properties of the units indicated and that the material will fit the space provided without requiring revisions to adjacent materials or systems.

2.1.1 Form Deck

Deck used as a permanent form for concrete shall conform to ASTM A 653 or ASTM A 611. Deck used as a form for concrete shall be fabricated of 26 gauge design thickness or thicker steel, and shall be zinc-coated in conformance with ASTM A 653, G60 coating class.

2.2 TOUCH-UP PAINT

Touch-up paint for zinc-coated units shall be an approved galvanizing repair paint with a high-zinc dust content. Welds shall be touched-up with paint conforming to SSPC Paint 20 in accordance with ASTM A 780. Finish of deck units and accessories shall be maintained by using touch-up paint whenever necessary to prevent the formation of rust.

2.3 ADJUSTING PLATES

Adjusting plates or segments of deck units shall be provided in locations too narrow to accommodate full-size units. As far as practical, the plates shall be the same thickness and configuration as the deck units.

2.4 CLOSURE PLATES

2.4.1 Cover Plates to Close Panels

Cover plates to close panel edge and end conditions and where panels change direction or abut. Butt joints in composite steel deck may receive a tape joint cover.

2.4.2 Sheet Metal

Where deck is cut for passage of pipes, ducts, columns, etc., and deck is to remain exposed, provide a neatly cut sheet metal collar to cover edges of deck. Do not cut deck until after installation of supplemental supports.

2.5 ACCESSORIES

The manufacturer's standard accessories shall be furnished as necessary to complete the deck installation. Metal accessories shall be of the same material as the deck and have minimum design thickness as follows: saddles, 0.0474 inch; welding washers, 0.0598 inch; cant strip, 0.0295 inch; other metal accessories, 0.0358 inch; unless otherwise indicated. Accessories shall include but not be limited to saddles, welding washers, cant strips, butt cover plates, underlapping sleeves, and ridge and valley plates.

PART 3 EXECUTION

3.1 ERECTION

Erection of deck and accessories shall be in accordance with SDI Pub No 28 and the approved detail drawings. Damaged deck and accessories including material which is permanently stained or contaminated, with burned holes or deformed shall not be installed. The deck units shall be placed on secure supports, properly adjusted, and aligned at right angles to supports before being permanently secured in place. The deck shall not be filled with concrete, used for storage or as a working platform until the units have been secured in position. Loads shall be distributed by appropriate means to

prevent damage during construction and to the completed assembly. The maximum uniform distributed storage load shall not exceed the design live load. There shall be no loads suspended directly from the steel deck.

3.2 ATTACHMENTS

All fasteners shall be installed in accordance with the manufacturer's recommended procedure, except as otherwise specified. The deck units shall be welded with nominal 5/8 inch diameter puddle welds or fastened with screws, powder-actuated fasteners or pneumatically driven fasteners to supports as indicated on the design drawings and in accordance with requirements of SDI Pub No 28. All welding of steel deck shall be in accordance with AWS D1.3 using methods and electrodes as recommended by the manufacturer of the steel deck being used. Welds shall be made only by operators previously qualified by tests prescribed in AWS D1.3 to perform the type of work required. Welding washers shall be used at the connections of the deck to supports. Welding washers shall not be used at sidelaps. Holes and similar defects will not be acceptable. Deck ends shall be lapped 2 inches. All partial or segments of deck units shall be attached to structural supports in accordance with Section 2.5 of SDI-02. Powder-actuated fasteners shall be driven with a low-velocity piston tool by an operator authorized by the manufacturer of the piston tool. Pneumatically driven fasteners shall be driven with a low-velocity fastening tool and shall comply with the manufacturer's recommendations.

3.3 HOLES AND OPENINGS

All holes and openings required shall be coordinated with the drawings, specifications, and other trades. Holes and openings shall be drilled or cut, reinforced and framed as indicated on the drawings or described in the specifications and as required for rigidity and load capacity. Holes and openings less than 6 inches across require no reinforcement. Holes and openings 6 to 12 inches across shall be reinforced by 0.0474 inch thick steel sheet at least 12 inches wider and longer than the opening and be fastened to the steel deck at each corner of the sheet and at a maximum of 6 inches on center. Holes and openings larger than 12 inches shall be reinforced by steel angles installed perpendicular to the steel joists and supported by the adjacent steel joists. Steel angles shall be installed perpendicular to the deck ribs and shall be fastened to the angles perpendicular to the steel joists. Openings must not interfere with seismic members such as chords and drag struts.

End of Section

DIVISION 5 - METALS

SECTION 05500

MISCELLANEOUS METAL

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SECTION 05500

MISCELLANEOUS METAL

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A14.3 (1992) Ladders - Fixed - Safety Requirements

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 36 (1996) Carbon Structural Steel

ASTM A 53 (1997) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

ASTM A 123 (1997a) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

ASTM A 467 (1993) Machine and Coil Chain

ASTM A 500 (1996) Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes

ASTM A 653 (1997) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

ASTM A 924 (1997a) Steel Sheet, Metallic-Coated by the Hot-Dip Process

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1 (1998) Structural Welding Code - Steel

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

NAAMM MBG 531 (1993) Metal Bar Grating Manual

NAAMM MBG 532 (1988) Heavy Duty Metal Bar Grating Manual

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-04 Drawings

Miscellaneous Metal Items; GA.

Detail drawings indicating material thickness, type, grade, and class; dimensions; and construction details. Drawings shall include catalog cuts, erection details, manufacturer's descriptive data and installation instructions, and templates. Detail drawings for all miscellaneous steel items.

SD-14 Samples

Miscellaneous Metal Items; GA.

Samples of the following items: (a) handrails, (b) grates. Samples shall be full size, taken from manufacturer's stock, and shall be complete as required for installation in the structure. Samples may be installed in the work, provided each sample is clearly identified and its location recorded.

1.3 GENERAL REQUIREMENTS

The Contractor shall verify all measurements and shall take all field measurements necessary before fabrication. Welding to or on structural steel shall be in accordance with AWS D1.1. Items specified to be galvanized, when practicable and not indicated otherwise, shall be hot-dip galvanized after fabrication. Galvanizing shall be in accordance with ASTM A 123, ASTM A 653, or ASTM A 924, as applicable. Exposed fastenings shall be compatible materials, shall generally match in color and finish, and shall harmonize with the material to which fastenings are applied. Materials and parts necessary to complete each item, even though such work is not definitely shown or specified, shall be included. Poor matching of holes for fasteners shall be cause for rejection. Fastenings shall be concealed where practicable. Thickness of metal and details of assembly and supports shall provide strength and stiffness. Joints exposed to the weather shall be formed to exclude water.

1.4 WORKMANSHIP

Miscellaneous metalwork shall be well formed to shape and size, with sharp lines and angles and true curves. Drilling and punching shall produce clean true lines and surfaces. Welding shall be continuous along the entire area of contact except where tack welding is permitted. Exposed connections of work in place shall not be tack welded. Exposed welds shall be ground smooth. Exposed surfaces of work in place shall have a smooth finish, and unless otherwise approved, exposed riveting shall be flush. Where tight fits are required, joints shall be milled. Corner joints shall be coped or mitered, well formed, and in true alignment. Work shall be accurately set to established lines and elevations and securely fastened in place. Installation shall be in accordance with manufacturer's installation instructions and approved drawings, cuts, and details.

1.5 ANCHORAGE

Anchorage shall be provided where necessary for fastening miscellaneous metal items securely in place. Anchorage not otherwise specified or indicated shall include slotted inserts made to engage with

the anchors, expansion shields, and power-driven fasteners when approved for concrete; toggle bolts and through bolts for masonry; machine and carriage bolts for steel; and lag bolts and screws for wood.

1.6 SHOP PAINTING

Surfaces of ferrous metal except galvanized surfaces, shall be cleaned and shop coated with the manufacturer's standard protective coating unless otherwise specified. Surfaces of items to be embedded in concrete shall not be painted. Items to be finish painted shall be prepared according to manufacturer's recommendations or as specified.

PART 2 PRODUCTS

2.1 PIPE GUARDS

Pipe guards shall be heavy duty steel pipe conforming to ASTM A 53, Type E or S, weight STD, black finish.

2.2 FLOOR GRATINGS AND FRAMES

Galvanized steel grating shall be designed in accordance with NAAMM MBG 531 or NAAMM MBG 532 to meet the indicated load requirements. Edges shall be banded with bars 1/4 inch less in height than bearing bars for grating sizes above 3/4 inch. Banding bars shall be flush with the top of bearing grating. Frames shall be of galvanized steel construction finished to match the grating.

2.3 FLOOR PLATES

Floor plates shall be 1/4 inch thick, raised thread galvanized steel.

2.4 HANDRAILS

Handrails shall be designed to resist a concentrated load of 200 pounds in any direction at any point of the top of the rail or 20 pounds per foot applied horizontally to top of the rail, whichever is more severe.

2.4.1 Steel Handrails, Including Carbon Steel Inserts

Steel handrails, including inserts in concrete, shall be steel pipe conforming to ASTM A 53 or structural tubing conforming to ASTM A 500, Grade A or B of equivalent strength. Steel railings shall be 1-1/2 inch nominal size. Railings shall be shop painted. Pipe collars shall be steel..

- a. Joint posts, rail, and corners shall be fabricated by one of the following methods:
 - (1) Flush type rail fittings of commercial standard, welded and ground smooth with railing splice locks secured with 3/8 inch hexagonal recessed-head setscrews.
 - (2) Mitered and welded joints by fitting post to top rail and intermediate rail to post, mitering corners, groove welding joints, and grinding smooth. Railing splices shall be butted and reinforced by a tight fitting interior sleeve not less than 6 inches long.
 - (3) Railings may be bent at corners in lieu of jointing, provided bends are made in suitable jigs and the pipe is not crushed.

- b. Removable sections, toe-boards, and brackets shall be provided as indicated.

2.5 LADDERS

Ladders shall be galvanized steel, fixed rail type in accordance with ANSI A14.3. Drawings indicate location where steel ladders are required.

2.6 MISCELLANEOUS

Miscellaneous plates and shapes for items that do not form a part of the structural steel framework, such as lintels, sill angles, miscellaneous mountings, and frames, shall be provided to complete the work.

2.7 ROOF SCUTTLES

Roof scuttles shall be of aluminum with 3 inch beaded flange welded and ground at corners. Scuttle shall be sized to provide minimum clear opening of 37 by 30 inches. Cover and curb shall be insulated with 1 inch thick rigid insulation covered and protected by aluminum sheet. The curb shall be equipped with an integral metal cap flashing of the same gauge and metal as the curb, full welded and ground at corners for weathertightness. Scuttle shall be completely assembled with heavy hinges, compression spring operators enclosed in telescopic tubes, positive snap latch with turn handles on inside and outside and neoprene draft seal. Fasteners shall be provided for padlocking on the inside. The cover shall be equipped with an automatic hold-open arm complete with handle to permit one hand release.

2.8 SAFETY CHAINS

Safety chains shall be galvanized welded steel, proof coil chain tested in accordance with ASTM A 467, Class CS. Safety chains shall be straight link style, 3/16 inch diameter, minimum 12 links per foot and with bolt type snap hooks on each end. Eye bolts for attachment of chains shall be galvanized 3/8 inch bolt with 3/4 inch eye, anchored as indicated. Two chains shall be furnished for each guarded opening.

2.9 SAFETY NOSING

Safety nosings shall be of cast iron with cross-hatched, abrasive surface. Nosing shall be 3 inches wide and terminating at not more than 6 inches from the ends of treads, except nosing for metal pan cement-filled treads shall extend the full length of the tread. Safety nosings shall be provided with anchors not less than 3/4 inch long. Integrally cast mushroom anchors are not acceptable.

2.10 STEEL STAIRS

Steel stairs shall be complete with structural or formed channel stringers, grating treads, landings, columns, handrails, and necessary bolts and other fastenings as indicated. Structural steel shall conform to ASTM A 36. Stairs and accessories shall be painted. Gratings for treads and landings shall conform to NAAMM MBG 531. Grating treads shall have slip-resistant nosings and shall be galvanized.

2.11 STEEL DOOR FRAMES

Steel door frames built from structural shapes shall be neatly mitered and securely welded at the corners with all welds ground smooth. Jambs shall be provided with 2 by 1/4 by 12 inch bent, adjustable metal anchors spaced not over 2 feet 6 inches on centers. Provision shall be made to stiffen the top member for all spans over 3 feet. Continuous door stops shall be made of 1-1/2 by 5/8 inch bars.

2.12 TRENCH COVERS, FRAMES, AND LINERS

Trench covers shall be designed to meet the indicated load requirements. Trench frames and anchors shall be all welded steel construction designed to match cover. Covers shall be secured to frame, shall have flush drop handles formed of 1/4 inch round stock, and shall be raised-tread, cast-iron grating as noted on drawings. Grating opening widths shall not exceed 1 inch. Trench liners shall be cast iron with integral frame for cover.

2.13 HEAVY DUTY FLAP GATE

The drainage gate shall be designed to allow free outflow and prevent backflow for maximum seating heads up to 55 feet.

The frame shall be cast iron of flatback design with machined seating surface inclined from vertical, at minimum of 2 1/2 degrees, to assure positive closure. For flatback gates mounted to thimbles or flanges, the gate flange shall be machined and drilled to match.

The cover shall be cast iron in one piece, with reinforcing ribs, designed to withstand the seating head specified. An integral cast on lifting eye shall be provided for manual operation.

Seating surfaces for frame and cover shall be bronze seats impacted into dovetail grooves on frame and cover.

All machine seats shall have a minimum 63 microinch finish.

The gate shall be provided with adjustable, double pivoted hinge links so designed to permit complete seating, full opening, and with stops or other arrangements to prevent cover from rotating sufficiently to become wedged in the open position. Pivot lugs mounted to frame shall be adjustable to allow adjustment of hinge links without having to remove cover from gate. The hinge links (arms) shall be bronze-brushed galvanized structural steel.

All assembly hardware and hinge pins shall be Type 18-8 stainless steel.

All cast iron shall be painted with manufacturer's standard shopcoat paint (or special paint). Structural steel hinge links shall be galvanized. All bronze and stainless steel parts do not require further finish.

PART 3 EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

All items shall be installed at the locations shown and according to the manufacturer's recommendations. Items listed below require additional procedures as specified.

3.2 INSTALLATION OF PIPE GUARDS

Pipe guards shall be set vertically in concrete piers. Piers shall be constructed of, and the hollow cores of the pipe filled with, concrete having a compressive strength of 3000 psi.

3.3 ATTACHMENT OF HANDRAILS

Installation of handrails shall be as detailed on drawings. Locate posts no closer than 6 inches to edge of concrete. Set in sleeves using epoxy grout. Handrails attached to steel framing to be welded to support unless detailed otherwise on drawings. Wall rails to be attached to concrete using wedge type expansion anchors.

Toeboards and brackets shall be installed where indicated. Splices, where required, shall be made at expansion joints. Removable sections shall be installed as indicated.

3.4 MOUNTING OF SAFETY CHAINS

Safety chains shall be mounted 3 feet 6 inches and 2 feet above the floor.

3.5 INSTALLATION OF SAFETY NOSINGS

Nosing shall be completely embedded in concrete before the initial set of the concrete occurs and shall finish flush with the top of the concrete surface.

3.6 TRENCH FRAMES AND COVERS

Trench frames and covers shall finish flush with the floor.

3.7 PAINTING

All miscellaneous steel items not galvanized shall be painted as specified in Section 09900 PAINTING, GENERAL.

End of Section

DIVISION 5 - METALS

SECTION 05900

SEISMIC PROTECTION FOR MECHANICAL, ELECTRICAL
EQUIPMENT & SUSPENDED CEILING SYSTEMS

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SECTION 05900

SEISMIC PROTECTION FOR MECHANICAL, ELECTRICAL
EQUIPMENT & SUSPENDED CEILING SYSTEMS

PART 1 GENERAL

1.1 REFERENCES

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 36	(1996) Carbon Structural Steel
ASTM A 307	(1994) Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength
ASTM A 325	(1997) High-Strength Bolts for Structural Steel Joints
ASTM A 501	(1996) Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
ASTM A 576	90b(1995)e1 Steel Bars, Carbon, Hot-Wrought, Special Quality
ASTM E 580	(1996) Suspension Systems for Acoustical Tile and Lay-in Panels in Areas Requiring Seismic Restraint.

1.2 DESCRIPTION

The requirements for seismic protection measures to be applied to mechanical/electrical equipment and systems specified herein are in addition to any other items called for in other sections of these specifications.

Mechanical/Electrical Equipment: Mechanical/electrical equipment shall include the following items to the extent required on plans or in other sections of these specifications:

- | | |
|---------------------------------|----------------------------------|
| 1. Water Heaters | 8. Drain, Waste and Vent Piping |
| 2. Control Panels | 9. Air & Refrigerant Compressors |
| 3. Pumps with Motors | 10. Air Handling Units |
| 4. Light Fixtures | 11. Switchgear |
| 5. Switchboards (Floor Mounted) | 12. Transformers |
| 6. Ceiling Fans | 13. Ducts |
| 7. Water Piping | |

Mechanical Systems: Mechanical systems shall include the following items to the extent required on plans or in other sections of these specifications:

- a. Water Supply Systems

b. Sanitary Sewer Systems

Miscellaneous Items: Miscellaneous items requiring seismic bracing shall include:

- a. Suspended acoustical ceiling assemblies.
- b. Storage Racks and shelf units.

1.3 SEISMIC ZONE

This facility is a Seismic Hazard Exposure Group "II" Seismic Zone 3 with $A_v = 0.30$.

1.4 PIPES AND DUCTS THAT DO NOT REQUIRE SPECIAL SEISMIC RESTRAINTS

Seismic restraints may be omitted from the following items:

- a. Piping other than gas or fuel oil piping in boiler and mechanical equipment rooms less than 1-1/4 inches inside diameter.
- b. All other piping except gas or fuel oil piping less than 2-1/2 inches inside diameter.
- c. All electrical conduit less than 2-1/2 inches inside diameter.
- d. All rectangular air handling ducts less than 6 square feet in cross sectional area.
- e. All piping and electrical conduit suspended by individual hangers 12 inches or less in length from the top of pipe or conduit to the bottom of the support for the hanger.
- f. All ducts suspended by hangers 12 inches or less in length from the top of the duct to the bottom of the support for the hanger.

1.5 SHOP DRAWINGS

Shop drawings along with catalog cuts, templates, and erection and installation details, as appropriate, for the items listed below shall be submitted. Submittals shall be complete in detail; shall indicate thickness, type, grade, class of metal, and dimensions; and shall show construction details, reinforcement, anchorage, and installation with relation to the building construction. Shop drawings and load calculations for each piece of equipment shall be prepared by a registered Professional Engineer.

Sway Braces
Flexible Couplings or Joints
Resilient Type Vibration Devices

1.6 DESIGN CRITERIA

Determination of seismic loads to be registered shall be as defined in Chapter 16 of The Standard Building Code, 1994 Edition.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

Materials and equipment shall conform to the respective specifications and other requirements specified below:

2.1.1 Bolts and Nuts

Squarehead bolts and heavy hexagon nuts, ASTM A 307 or ASTM A 576.

Bolts, underground, ASTM A 325.

2.1.2 Sway Brace

Material used for members listed in Tables I and III of this specification, except for pipes, shall be structural steel conforming with ASTM A 36. Steel pipes shall conform to ASTM A 501.

2.1.3 Flexible Couplings

Flexible couplings shall have same pressure ratings as adjoining pipe.

Flexible ball joints conforming to the following requirements may be employed on aboveground piping. Joints shall have cast or wrought steel casing and ball parts capable of 360-degree rotation plus not less than 15-degree angular movement. Joints shall be certified to be suitable for the service intended by the manufacturer, based on not less than 2 years' satisfactory operation in a similar application.

Flexible couplings and joints of the mechanical joint type may be used for aboveground or underground piping.

Mechanical couplings for steel or cast-iron pipe shall be of the sleeve type and shall provide a tight flexible joint under all reasonable conditions, such as pipe movement caused by expansion, contraction, slight settling or shifting of the ground, minor variations in trench gradients, and traffic vibrations. Where permitted in other sections of these specifications, joints utilizing split-half couplings with grooved or shouldered pipe ends may be used.

Sleeve-type couplings shall be used for joining plain-end pipe sections. The coupling shall consist of one steel middle ring, two steel followers, two gaskets, and necessary steel bolts and nuts to compress the gaskets. Underground bolts shall be high-strength type as specified above.

2.1.4 Guy Wires

Guy wires shall conform to Fed. Spec. RR-W-410 as follows:

5/32 inch diameter	Type V, Class 1
3/16 inch to 5/16 diameter	Type V, Class 2
1/4 inch to 5/8 diameter	Type I, Class 2

PART 3 EXECUTION

3.1 SWAY BRACES

- a. SWAY BRACES shall be installed on piping and duct to preclude damage during seismic activity. All bracing shall conform to the arrangements shown. Provisions of this paragraph apply to all piping within a 5-foot line around outside of building unless buried in the ground. Piping grouped for support on trapeze-type hangers shall be braced at the same intervals as determined by the smallest diameter pipe of the group.
- b. No trapeze-type hanger shall be secured with less than two ½-inch bolts. Bracing rigidly attached to pipe flanges, or similar, shall not be used where it would interfere with thermal expansion of piping.
- c. Sway Braces for Piping
- d. Transverse Sway Bracing: Transverse sway bracing shall be provided at intervals not to exceed those given in Table II except for cast-iron soil pipe, which shall be braced at not more than 10-foot intervals.
- e. Longitudinal Sway Bracing: Longitudinal sway bracing shall be provided at 40-foot intervals.
- f. Vertical Runs: Vertical runs of piping shall be braced at not more than 10-foot vertical intervals. For smaller tubing, bracing shall be provided at no more than 4-foot spacing.
- g. Anchor Rods, Angles, and Bars: Anchor rods, angles, and bars shall be bolted to either pipe clamps or pipe flanges at one end and cast-in-place concrete or masonry insert or clip angles bolted to the steel structure on the other end. Rods shall be solid metal or pipe as specified below. Anchor rods, angles, and bars shall not exceed lengths given in Table III.
- h. Clamps: Clamps on uninsulated pipes shall be applied directly to pipe. Insulated piping shall have clamps applied over insulation vapor barrier with high-density inserts and metal protection shields under each clamp.
- i. Bolts: Bolts used for attachment of anchors to pipe and structure shall be not less than ½-inch diameter.

3.1.1 Sway Braces for Ducts

- a. Transverse Sway Bracing: Transverse sway bracing shall be provided at each horizontal turn of 45 degrees or more, at the end of each duct run, and otherwise at each 30-foot interval. Walls which ducts penetrate may be considered transverse braces.
- b. Longitudinal Sway Bracing: Longitudinal sway bracing shall be provided at 60-foot intervals. Transverse bracing for one duct section may also act as longitudinal bracing for a duct section connected perpendicular to it, if the bracing is installed within 4 feet of the intersection, and it is sized for the larger duct.
- c. Bracing Angles: Bracing angles for rectangular ducts shall be in accordance with Table I.

TABLE I
SCHEDULE OF BRACING FOR RECTANGULAR DUCTS
(Angle and bolt sizes apply to all seismic zones)

Duct Size*	Vertical and Longt'l Angles	Diagonal Angles	Horizontal Angles	Bolt Size
30" sq.	2x2x16 gage	2x2x16 gage	2x2x16 gage	1/4"
42" sq.	2-1/2x2-1/2x16 gage	2-1/2x2-1/2x16 gage	2-1/2x2-1/2x16 gage	1/4"
54" sq.	2-1/2x2-1/2x16 gage	2-1/2x2-1/2x14 gage	2-1/2x2-1/2x16 gage	3/8"
60" sq.	3x3x16 gage	3x3x14 gage	3x3x16 gage	3/8"

* The ducts maximum dimension shall govern what bracing is required. Example: a 36" x 60" duct shall be braced as a 60-inch square duct.

3.2 SPREADERS

Spreaders shall be provided between racked or adjacent piping runs to prevent contact during seismic activity whenever pipe or insulated pipe surfaces are less than 4 inches apart or four times the maximum displacement due to seismic force. Spreaders to be applied at same interval as sway braces. Spreaders shall be applied to surface of bare or insulated hot pipe and over insulation utilizing high-density inserts and pipe protection shields where vapor-barrier-type insulation is employed.

TABLE II
MAXIMUM SPAN FOR TRANSVERSE SWAY BRACES IN SEISMIC ZONE 3

Pipe Diameter	Std. Wgt. Steel Pipe – 40S		Copper Tube Type L	
(in.)	*L(ft)	**F(lbs)	*L(ft)	**F(lbs)
1	24.2	56	12.1	13.6
1-1/2	27.5	112	13.2	28
2	31.9	176	15.4	56
2-1/2	35.2	304	16.5	88
3	37.4	440	18.7	120
3-1/2	39.6	584	19.8	176
4	42.9	768	20.9	240

*L = Maximum span between lateral supports.

**F = Horizontal force on the brace.

NOTE: Bracing shall consist of at least one vertical angle 2 x 2 x 16 gage and one diagonal angle of the same size.

TABLE III
MAXIMUM LENGTH FOR ANCHOR BRACES

<u>Type</u>	<u>Size</u>	<u>Maximum Length*</u>	<u>Allowable Loads* (kips)</u>
Angles	1-1/2" x 1-1/2" x 1/4"	4'-10"	5.7
	2" x 2" x 1/4"	6'-6"	7.8
	2-1/2" x 1-1/2" x 1/4"	8'-0"	9.8
	3" x 2-1/2" x 1/4"	8'-10"	10.8
	3" x 3" x 1/4"	9'-10"	11.9
Rods	3/4"	3'-1"	3.7
	7/8"	3'-8"	5.0
Flat Bars	1-1/2" x 1/4"	1'-2'	3.1
	2" x 1/4"	1'-2"	4.1
	2" x 3/8"	1'-9"	6.2
Pipes (40S)	1"	7'-0"	4.1
	1-1/4"	9'-0"	5.5
	1-1/2"	10'-4"	6.6
	2"	13'-1"	8.9

* Based on the slenderness ratio of $1/r = 200$ and ASTM A 36 steel.

3.3 FLEXIBLE COUPLINGS OR JOINTS

Building Piping: Flexible couplings or joints in building piping shall be provided at bottom of all pipe risers larger than 3-1/2 inches in diameter. Cast-iron waste and vent piping need only comply with these provisions when caulked joints are used. Flexible bell and spigot pipe joints using rubber gaskets or no-hub fittings may be used at each branch adjacent to tees and elbows for underground waste piping inside of building to comply with these requirements.

Underground Piping: All underground piping and 4-inch or larger conduit, except heat distribution system, shall have flexible couplings installed adjacent to building as shown. Additional flexible couplings shall be provided as follows:

- a. At all points that can be considered to act as anchors.
- b. On every branch of a tee and each side of an elbow.

3.4 ANCHOR BOLTS

All floor or pad mounted equipment required by any Section of these specifications shall use cast-in-place anchor bolts. Two nuts shall be provided on each bolt. Anchor bolts must conform to ASTM A 307. Anchor bolts shall have an embedded straight length equal to at least twelve times nominal diameter of the bolt. If the size and number of the anchor bolts are not shown on the drawings then anchor bolts shall conform to the following table of sizes for the various equipment weights or the manufacturer's installation recommendations, whichever is the most stringent.

Maximum Equipment Weight (Pounds)	Minimum Bolt Sizes (Inches)* Zone 3
500	1/2
1,000	1/2
5,000	1/2
10,000	1/2
20,000	1/2
30,000	5/8
50,000	3/4
100,000	1

* Based on four bolts per item, a minimum embedment of 12 bolt diameters, a minimum bolt spacing of 16 bolt diameters and a minimum edge distance of 12 bolt diameters. Use equivalent total cross-sectional area when more than four bolts per item are provided. Anchor bolts that exceed normal depth of equipment foundation piers or pads shall either extend into concrete floor or the foundation shall be increased in depth to accommodate bolt lengths.

Expansion anchors shall not be used to resist seismic or vibratory loads unless test data are provided to verify the adequacy of the specific anchor and application. In no case shall the expansion anchor size be less than that required for bolts in the preceding table.

3.5 RESILIENT VIBRATION ISOLATION DEVICES

Selection of anchor bolts for vibration isolation devices and/or snubbers to equipment base and foundations shall follow the same procedure as in paragraph ANCHOR BOLTS except that an equipment weight equal to five times the actual equipment weight shall be used.

Multidirectional Seismic Snubbers: Multidirectional seismic snubbers employing elastomeric pads shall be installed on all floor- or slab-mounted equipment. These snubbers shall provide 0.25-inches free vertical and horizontal movement from the static deflection point. Snubber medium shall consist of multiple pads of cotton duct and neoprene or other suitable materials arranged around a flanged steel trunnion so both horizontal and vertical forces are resisted by the snubber medium.

3.6 EQUIPMENT SWAY BRACING

Equipment sway bracing shall be provided for all items supported from overhead floor or roof structures. Braces shall consist of angles, rods, bars, or pipes arranged as shown and secured at both ends with not less than 1/2-inch bolts. Braces shall conform to Table III. Bracing shall be provided in two planes of directions, 90 degrees apart, for each item of equipment. Sufficient braces shall be provided for equipment to resist a horizontal force equal to 113 percent of the weight of equipment without exceeding safe working stress of bracing components. Details of all equipment bracing shall be submitted for approval. In lieu of bracing with vertical supports, these items may be supported with hangers inclined at 45 degrees directed up and radially away from equipment and oriented symmetrically in 90-degrees intervals on the horizontal plane, bisecting the angles of each corner of the equipment, provided that supporting members are properly sized to support operating weight of equipment when hangers are inclined at a 45-degree angle.

3.7 LIGHTING FIXTURES IN BUILDINGS

In addition to the requirements of the preceding paragraphs, lighting fixtures and supports shall conform to the following:

3.7.1 Materials and Construction

- a. Fixture supports shall be malleable iron.
- b. Loop and hook or swivel hanger assemblies for pendant fixtures shall be fitted with a restraining device to hold the stem in the support position during earthquake motions. Pendant-supported fluorescent fixtures shall also be provided with a flexible hanger device at the attachment to the fixture channel to preclude breaking of the support. The motion of swivels or hinged joints shall not cause sharp bends in conductors or damage to insulation.
- c. Recessed fluorescent individual or continuous-row fixtures shall be supported by a seismic-resistant suspended ceiling support system and shall be provided with fixture support wires attached to the building structural members using two wires for individual fixtures and one wire per unit of continuous row fixtures.
- d. A supporting assembly that is intended to be mounted on an outlet box shall be designed to accommodate mounting features on 4-inch boxes, 3-inch plaster rings, and fixture studs.
- e. Surface-mounted fluorescent individual or continuous-row fixtures shall be attached to a seismic-resistant ceiling support system. Fixture support devices for attaching to suspended ceilings shall be a locking-type scissor clamp or a full loop band that will securely attach to the ceiling support. Fixtures attached to underside of a structural slab shall be properly anchored to the slab at each corner of the fixture.
- f. Each wall-mounted emergency light unit shall be secured in a manner to hold the unit in place during a seismic disturbance.

3.7.2 Tests

In lieu of the requirements for equipment supports, lighting fixtures and the complete fixture-supporting assembly may be tested as specified hereinafter. Such tests shall be conducted by an approved and independent testing laboratory, and the results of such tests shall specifically state whether or not the lighting fixture supports satisfy the requirements given herein.

- a. Test Equipment: To simulate earthquake motion, fixtures and supports shall be attached to a carriage suspended on rollers from an overhead track. A gear motor and crank assembly shall be used to provide oscillatory motion of approximately one cycle per second. The exact number of cycles per second and the actual dimensions of the crank apparatus shall be adjusted to produce a minimum carriage acceleration of 0.28g. The actual fixture-mounting surface shall be on the underside of the carriage and shall provide capacity for orienting the fixture in a horizontal plane in various positions, ranging from parallel to perpendicular to the line of traverse.
- b. Test Requirements: All tests shall be conducted with the maximum fixture weight so as to produce the most severe loading conditions. Fixtures having stems shall be tested with the actual stem lengths to be used. Tests shall be of 1-minute duration with the mounting

surface in the line of traverse, at 45 degrees to the line of traverse, and at 90 degrees to the line of traverse. A total of two fixtures shall be tested in each of the above positions. After each of the six tests, the complete stem assemblies from fixtures having stem assemblies shall be subjected to a tensile strength test. The sample shall withstand, without failure, a force of not less than four times the weight it is intended to support.

- c. Acceptance: No component of a fixture nor its supports shall be accepted individually. For acceptance, the fixture and its supports shall exhibit no undue damage, and no component of the fixture shall fail or fall from the fixture during testing.

3.7.3 Design Criteria

In lieu of the above test requirements, lighting fixtures shall be designed to resist a lateral force of 113 percent of the fixture weight.

3.8 SUSPENDED ACOUSTICAL CEILING ASSEMBLIES

The structural members of ceiling systems used primarily to support acoustical tile panels or acoustical panel lay-in tiles, with or without lighting fixtures, ceiling-mounted air terminals, and ceiling-mounted services, shall conform to the following:

3.8.1 Design Criteria

The main runners and cross-runners and their splices and intersection connections shall be designed for two times the design load or ultimate axial tension or compression (minimum 120 pounds). The connections at the splices and intersections shall be of a mechanical interlocking type that cannot easily be disengaged. All ceiling structural systems shall be designed to withstand required vertical load as well as a lateral force of 23 percent of the ceiling weight. The ceiling weight shall include all lighting fixtures and other equipment that are laterally supported by the ceiling and shall be not less than 4.0 psf. Exception: Ceiling areas of 144 square foot or less surrounded by walls that connect directly to the structure above shall be exempt from the lateral-load standards of this specification.

3.8.2 Minimum Installation Requirements

Minimum installation requirements shall be in accordance with ASTM E 580 as follows:

3.8.3 Vertical Support

Hanger wires supporting a maximum tributary ceiling area of 16 square foot shall be a minimum of 12 gage in diameter. The size of wires supporting a tributary ceiling area greater than 16 square foot shall be substantiated by design calculations. Hanger attachment devices used in ceiling systems not exceeding 4 psf shall be capable of supporting a minimum allowable load of 100 pounds. Hanger attachment devices used in ceiling systems exceeding 4 psf shall be capable of supporting the design load and shall be substantiated by design calculations. Hangers shall be plumb and shall not attach to or bend around interfering duct pipes or similar obstructions. If hangers must be splayed more than one horizontal to six vertical, the resulting horizontal force shall be offset by bracing, counter-splaying, or other acceptable means and substantiated by design calculations. The terminal end of each cross runner or main runner shall be supported independently and within 8 inches of a wall.

3.8.4 Lateral Support

In lieu of the design criteria stated above, where ceiling loads do not exceed 4 psf, lateral support for the ceiling system may be provided by four wires of minimum No. 12 gage, splayed in four directions, 90 degrees apart, and connected to the main runner within 2 inches of the cross runner and to the structure above at an angle not exceeding 45 degrees from the plane of the ceiling. These lateral support points shall be placed 12 feet on center in each direction with the first point within 4 foot from each wall. Allowances shall be made for lateral movement of the system. Main runners and cross runners may be attached at two adjacent walls with clearance between the walls and the runners maintained at the other two walls.

3.8.5 Lighting Fixture and Air Diffuser Supports

Lighting fixture and air diffuser supports shall be designed and installed to meet the requirements of equipment supports in the preceding paragraphs of this specification with the following exceptions:

- a. Recessed lighting fixtures not over 56 pounds in weight and suspended and pendent-hung fixtures not over 20 pounds in weight may be supported and attached directly to the ceiling system runners by a positive attachment such as screws or bolts.
- b. Air diffusers that weigh not more than 20 pounds and that receive no tributary loading from ductwork may be positively attached to and supported by the ceiling runners.

3.9 MISCELLANEOUS EQUIPMENT

The following specific items of equipment to be furnished under this contract shall be constructed and assembled so as to be capable of withstanding the horizontal equivalent static force of 0.23 times the operating weight of the equipment, at vertical center of gravity of the equipment without causing permanent deformation, dislocations, separation of components, or other damage, which would render the equipment inoperative for significant periods of time following an earthquake.

- a. Boilers
- b. Air-Handling Units
- c. Engine-Generators
- d. Transformers
- e. Switch Boards and Switch Gears
- f. Motor Control Centers
- g. Free Standing Electric Motors

End of Section

DIVISION 5 - METALS

SECTION 05914

VERTICAL LIFT SLUICE GATES

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SECTION 05914

VERTICAL LIFT SLUICE GATES

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 36/A 36M	(2003a) Carbon Structural Steel
ASTM A 53	(1999b) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 240/A 240M	(2003c) Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels
ASTM A 276	(2003) Stainless and Heat-Resisting Steel Bars and Shapes
ASTM A 307	(2002) Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength
ASTM A 325	(2002) Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A 564/A 564M	(2002a) Hot-Rolled and Cold-Finished Age-Hardening Stainless and Heat-Resisting Steel Bars and Shapes
ASTM D 395	(2003) Rubber Property - Compression Set
ASTM D 412	(1998a; R 2002e1) Vulcanized Rubber and Thermoplastic Rubber and Thermoplastic Elastomers - Tension
ASTM D 413	(1998; R 2002e1) Rubber Property - Adhesion to Flexible Substrate
ASTM D 471	(1998e1) Rubber Property - Effect of Liquids
ASTM D 572	(1999)e1 Rubber - Deterioration by Heat and Oxygen
ASTM D 2240	(2003) Rubber Property - Durometer Hardness

NATIONAL ELECTRIC MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 6

Industrial Control and Systems, Enclosures

NEMA MG 1

Motors and Generators

1.2 SUBMITTALS

Government approval is required for all submittals with a "GA" designation; submittals having an FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-04 Drawings

Detail Drawings; GA.

Submit detail drawings.

SD-07 Schedules

Materials; FIO.

Submit material orders, material lists, and material shipping bills.

SD-08 Statements

Welding Procedures for Structural Steel; GA.

Submit schedules of welding procedures for structural steel.

SD-09 Reports

Tests, Inspections and Verifications; FIO.

Submit certified material test reports with all material delivered to the site.

Acceptance Trial Operation and Test; FIO.

Submit operation and test results before completion of the contract .

SD-18 Records

Materials Disposition; FIO.

Submit system of identification which shows the disposition of specific lots of approved materials and fabricated items in the work before completion of the contract.

1.3 DELIVERY, STORAGE, AND HANDLING

Delivery, handling, and storage of materials and fabricated items shall conform to the requirements specified.

1.3.1 Rubber Seals

Rubber seals shall be stored in a place which permits free circulation of air, maintains a temperature of 70 degrees F or less, and prevents the rubber from being exposed to the direct rays of the sun. Rubber seals shall be kept free of oils, grease, and other materials which would deteriorate the rubber. Rubber seals shall not be distorted during handling.

PART 2 PRODUCTS

2.1 MATERIALS

Materials orders, material lists and material shipping bills shall conform with the requirements of Section 05101 METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS.

2.1.1 Metals

Structural steel, monel, babbitt, steel forgings, steel castings, stainless steel, bronze, aluminum bronze, brass and other metal materials used for fabrication shall conform to the requirements as shown and as specified herein.

2.1.1.1 Structural Steel

Structural steel shall conform to ASTM A 36/A 36M.

2.1.1.2 Structural Steel Plates

Structural steel plates shall conform to ASTM A 36/A 36M.

2.1.1.3 Steel Pipe

Steel pipe shall conform to ASTM A 53, Type S, Grade B, seamless, black, nominal size and weight class or outside diameter and nominal wall thickness as shown, plain ends.

2.1.1.4 Stainless Steel Bars and Shapes

Stainless steel bars and shapes shall conform to ASTM A 276, UNS S 30400, Condition A, hot-finished or cold-finished, Class C; or ASTM A 564/A 564M, UNS S 17400, Condition A, age-hardened heat treatment, hot-finished or cold-finished, Class C.

2.1.1.5 Stainless Steel Plate, Sheet, and Strip

Stainless steel plate, sheet, and strip shall conform to ASTM A 240/A 240M, UNS S 30400. Plate finish shall be hot-rolled, annealed or heat-treated, and blast-cleaned or pickled. Sheet and strip finish shall be No. 1.

2.1.2 Rubber Seals

Rubber seals shall be compounded of natural rubber, synthetic polyisoprene, or a blend of both, and shall contain reinforcing carbon black, zinc oxide, accelerators, antioxidants, vulcanizing agents, and plasticizers.

2.1.2.1 Physical Characteristics

Physical characteristics of the seals shall meet the following requirements:

PHYSICAL TEST	TEST VALUE	TEST METHOD SPECIFICATION
Tensile Strength	2500 psi (min.)	ASTM D 412
Elongation at Break	450 percent (min.)	ASTM D 412
300 percent	900 psi (min.)	ASTM D 412
Durometer Hardness (Shore Type A)	60 to 70	ASTM D 2240
*Water Absorption	5 percent by weight (max.)	ASTM D 471
Compression Set	30 percent (max.)	ASTM D 395
Tensile Strength (after aging 48 hrs)	80 percent of tensile strength (min.)	ASTM D 572

* The "Water Absorption" test shall be performed with distilled water. The washed specimen shall be blotted dry with filter paper or other absorbent material and suspended by means of small glass rods in the oven at a temperature of 70 degrees C plus or minus 2 degrees for 22 hours plus or minus 1/4 hour. The specimen shall be removed, allowed to cool to room temperature in air, and weighed. The weight shall be recorded to the nearest 1 mg as M subscript 1 (M subscript 1 is defined in ASTM D 471). The immersion temperature shall be 70 degrees C plus or minus 1 degree and the duration of immersion shall be 166 hours.

2.1.2.2 Fabrication of Rubber Seals

Rubber seals shall have a fluorocarbon film vulcanized and bonded to the sealing surface of the bulb. The film shall be 0.030 inches thick Huntington Abrasion Resistant Fluorocarbon Film No. 4508, or equal, and shall have the following physical properties:

Tensile strength	2,000 psi (min.)
Elongation	250 percent (min.)

The outside surface of the bonded film shall be flush with the surface of the rubber seal and shall be free of adhering or bonded rubber. Strips and corner seals shall be molded in lengths suitable for obtaining the finish lengths shown and with sufficient excess length to provide test specimens for testing the adequacy of the adhesion bond between the film and bulb of the seal. At one end of each strip or corner seal to be

tested, the fluorocarbon film shall be masked during bonding to prevent a bond for a length sufficient to hold the film securely during testing.

2.1.3 Motorized Hoist Unit

2.1.3.1 Motor

Electric motors shall be specifically designed for the motorized hoist unit, and shall be totally enclosed, non-ventilated. As a minimum, the electric motor enclosure shall meet NEMA ICS 6 Type 4 weatherproof construction. Motors shall be capable of operating through one complete cycle, open-close-open or close-open-close, under the maximum specified operating conditions when voltage to the motor is plus or minus 10 percent of the specified voltage. Motors shall have Class F insulation with 155 degrees C maximum continuous temperature rating of 155 degrees C (rise plus ambient) for the 30 minute specified duty cycle. Overload protection shall be by means of inherent motor thermal sensors embedded in the windings.

Power to the motorized hoist unit shall be 460 volt, single phase, 60 Hz. and shall have sufficient horsepower to operate the hoist to full gate travel without exceeding the full load ampere rating and conform to the NEMA Publication MG 1. The motor shall be specifically designed for valve actuator service and shall be of high starting torque, totally enclosed, non-ventilated construction.

2.1.3.2 Power Gearing

The motorized hoist unit shall be a multiple reduction unit with power gearing consisting of spur, helical, or bevel gears, and worm gearing. The spur, helical, or bevel gearing, and worm shall be of hardened alloy steel, and the worm gear shall be alloy bronze. All gearing shall be accurately cut. Non-metallic, aluminum or cast gearing in power train are not allowed. Anti-friction bearings shall be used throughout.

2.1.3.3 Lubrication

All gearing and bearings shall be grease or oil lubricated. Seals shall be provided at all exit points of the gear case to prevent leakage of lubricant. Critical areas subject to high wear shall be double sealed. Lubricants shall be suitable for year-round service for ambient conditions of minus 20 degrees F to 150 degrees F.

2.1.3.4 Stem Nut

The motorized hoist unit shall have a removable stem nut (or drive bushing) of high tensile bronze or other material compatible with the valve stem material.

2.1.3.5 Self-Locking Feature

Motorized hoist unit gearing and/or stem treading shall be self-locking.

2.1.3.6 Lost Motion Device

The motorized hoist unit shall have a built-in device, incorporated in the power train and located between the worm gear and drive sleeve, to permit load impact under dynamic efficiency conditions, with a hammer blow effect, to allow the motor to reach full speed before engaging the valve load.

When motorized hoist units are provided with modulating service controls, the lost motion device is not desired, and thus not required.

2.1.3.7 Handwheel

The motorized hoist unit shall be equipped with a handwheel for manual operation, so connected that operation by motor shall not cause the handwheel to rotate, and operation by handwheel shall not cause the motor to rotate. The handwheel clutch design shall prevent transmission of the motor torque to the handwheel should power be returned to the motor while the handwheel is in use. A fused motor shall not prevent manual operation. Use of the handwheel shall not negate the hammer blow feature. The handwheel shall require an effort of no more than 60 pounds on the rim for seating or unseating load, or 40 pounds for running load. The handwheel shall have an arrow and the word "Open" indicating required rotation. The handwheel shall operate in the clockwise direction to close. External declutch lever will be padlockable in either the manual (handwheel) or motor mode. Friction type declutch mechanisms are not acceptable.

2.1.3.8 Stem Cover and Position Indication

All gates shall have rising stems unless otherwise noted, and shall be provided with a galvanized metal pipe stem cover. The cover shall be of sufficient diameter and length to permit full travel of threaded stem without obstruction. The top of the stem cover shall be capped and the bottom end vented, drained, and threaded with national pipe threads for easy field installation.

Position indication for gates with metal stem covers shall be accomplished by means of an indicator dial in full step at all times with valve travel, whether in power or manual operation. The indicator dial shall be graduated in 25 percent increments as a minimum; closed, quarter open, half open, three-quarters open, and open to provide continuous indication of gate position at all times.

2.1.3.9 Limit Switches

Open and close limit switches shall be geared to the drive mechanism and be in step at all times, whether the unit is operated electrically or manually. The switches shall be of the rotary drum wiping action contact type, field adjustable, and capable of being set either open, fully closed, or at any intermediate point. Limit switch contacts shall be solid silver and have a minimum rating of 10 amps (break) inductive at 120 VAC. Limit switch gearing shall be grease lubricated. The drive mechanism shall be totally enclosed to prevent entrance of foreign matter. Use of cams or set screws in securing switches or the drive system is unacceptable.

The motorized hoist unit shall have a minimum of 8 contacts, 4 contacts/2 rotor types, all of the same basic design. Contacts shall be convertible from N/O to N/C or reverse. Switch design shall permit visual verification of switch position without disassembly.

2.1.3.10 Torque Switch

Each motorized hoist unit shall be equipped with a switch that will interrupt the control circuit in both the opening and closing directions when valve torque overload occurs or when valves require torque seating in the closed or open position. Contacts shall be silver plated. The torque switch shall have graduated dials for both open and close directions of travel and each shall be independently adjustable, with a positive means to limit the adjustability so as not to exceed the motorized hoist unit output torque capability. Switch design shall permit visible verification of switch position without disassembly.

2.1.3.11 Electrical Controls Enclosure (Switch Compartment)

Terminal strips, space heater, limit and torque switches, and any other specified electrical accessories, shall be prewired, supplied in a modular form and be housed in a single switch compartment meeting NEMA ICS 6 Type 4 weatherproof construction. The space heater shall be wired for separate service voltage supply at 120 volt AC. The access to the switch compartment shall be lockable.

2.1.3.12 Electrical Controls

All electrical controls shall be supplied integral in the motorized hoist unit switch compartment and shall be pre-mounted and shop-wired to a terminal strip(s) to facilitate a minimum of field wiring at the time of installation. A main power disconnect shall be also provided inside the switch compartment.

a. Open-Close and Trotting Service Controls shall include but not be limited to:

1. Reversing Contactor: The control voltage shall be 120 volts, single phase, 60 HZ. Seal-in latching contacts shall be supplied for use in push button circuits. Additional spare auxiliary contacts (1 N.O. and 1 N.C.) shall be supplied. Starter shall be both electrically and mechanically interlocked.
2. Control Power Transformer: Transformer shall be designed to transform 460 volts, 60 HZ power to 120 volts, single phase. The transformer shall be complete with a grounded and fused secondary.
3. Push Buttons: Each motorized hoist unit shall be supplied complete with open-stop-close push buttons.

Indication Light(s) wired as indicated on the plans. Local and remote indication lights are wired for separate power supply.

Each motorized hoist unit shall be furnished complete with open-close lights for indication of gate position. Lenses shall be red for open and green for close. Both lamps shall be lighted during intermediate travel.

2.2 MANUFACTURED UNITS

Bolts, nuts, washers, screws and other manufactured units shall conform with the requirements as shown and as specified herein.

2.2.1 Bolts, Nuts and Washers

High-strength bolts, nuts, and washers shall conform to ASTM A 325, hot-dip galvanized. Bolts, nuts, studs, stud bolts and bolting materials other than high-strength shall conform to ASTM A 307, Grade A, hot-dip galvanized. Bolts 1/2 inch and larger shall have hexagon heads. The finished shank of bolts shall be long enough to provide full bearing. Washers for use with bolts shall conform to the requirements specified in the applicable specification for bolts.

2.2.2 Screws

Screws shall be of the type indicated.

2.3 FABRICATION

2.3.1 Detail Drawings

Detail drawings, including fabrication drawings, shop assembly drawings, delivery drawings, and field installation drawings, shall conform to the requirements specified and in Section 05101 METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS.

2.3.1.1 Fabrication Drawings

Fabrication drawings shall show complete details of materials, tolerances, connections, and proposed welding sequences which clearly differentiate shop welds and field welds.

2.3.1.2 Shop Assembly Drawings

Shop assembly drawings shall provide details for connecting the adjoining fabricated components in the shop to assure satisfactory field installation.

2.3.1.3 Delivery Drawings

Delivery drawings shall provide descriptions of methods of delivering components to the site, including details for supporting fabricated components during shipping to prevent distortion or other damages.

2.3.1.4 Field Installation Drawings

Field installation drawings shall provide a detailed description of the field installation procedures. The description shall include the location and method of support of installation and handling equipment; provisions to be taken to protect concrete and other work during installation; method of maintaining components in correct alignment; plan for prestressing gate leaf diagonals, which shall include descriptions of connections, riggings, anchorages, and measuring equipment; methods for installing quoin and miter blocks, including checking and maintaining alignments of the blocks during concreting and placement of epoxy filler; and methods for installing other appurtenant items.

2.3.2 Structural Fabrication

Structural fabrication shall conform to the requirements as shown and specified herein and in Section 05101 METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS. Dimensional tolerances shall be as specified and as shown. Splices shall occur only where shown. Pin holes shall be bored in components after welding, straightening, stress-relieving, and threading operations are completed. Brackets, eye bar sections, and other components requiring straightening shall be straightened by methods which will not damage the material. Bushings shall be press-fitted with supporting components. Bolt connections, lugs, clips, or other pick-up assembly devices shall be provided for components as shown and required for proper assembly and installation.

2.3.2.1 Welding

Welding shall conform with the requirements specified and in Section 05101 METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS. Welds shall be of the type shown on approved detail drawings.

Components shall be stress-relief heat treated after welding where shown. Stress-relieving of components shall be performed prior to the attachment of miscellaneous appurtenances.

2.3.2.2 Bolted Connections

Bolted connections shall conform with the requirements specified in Section 05101 METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS.

2.3.2.3 Machine Work

Machine work shall conform with the requirements specified in Section 05101 METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS.

2.3.2.4 Miscellaneous Provisions

Miscellaneous provisions for fabrication shall conform with the requirements specified herein and in Section 05101 METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS.

2.3.3 Square Wall Thimble

Wall thimble shall be a heavy, one-piece casting of an “F” joint type configuration. A water stop shall be cast around the periphery of the thimble. The front face shall be machined to a plane and holes drilled and tapped to mate the drilling pattern of the gate frame. The vertical centerline shall be clearly and permanently marked at the top and bottom to permit alignment of the front face in the vertical plane. The wall thimble shall be provided with grout holes in the invert to permit trapped air to escape. Mastic or a rubber gasket of uniform thickness shall be provided to form a seal between the front face of the thimble and the back of the gate frame.

2.3.4 Sluice Gate

Sluice gate shall be cast iron and shall be of one-piece construction. A nut pocket shall be cast on the vertical centerline of the gate and shall be provided with a threaded block for attaching the stem to the sluice gate. Pads for side wedges and top and bottom wedges, when required, shall be integrally cast on the slide and machined to receive the adjustable wedges. The overall width and height of the fabricated gate leaf shall not vary from the respective dimensions shown by more than 1/16 inch. Top, bottom and side bar seals shall be firmly butted together at the corners. For a flush-bottom gate, the ends of side bar seals shall be flush with the bottom seating surface of the gate. Final machining of bar seals shall be performed after they are attached to the gate. The bottom seat of flush-bottom gate shall be machined for a tight fit with the gate frame seal.

2.3.5 Sluice Gate Frame and Guides

Sluice gate frame and guides shall be cast iron and shall be a one-piece integral casting. The back of the frame shall be machined to a plane and drilled to match the wall thimble bolt pattern. Guiding and seal surfaces of sluice gate frame shall be in a true vertical plane and shall be machine finished. Unmachined surfaces exposed to water flow shall match at joints between component parts, shall not depart from true planes shown by more than 1/16 inch and shall be free of offsets or irregularities greater than 1/16 inch. Allowable offsets or irregularities less than 1/16 inch shall be ground to a bevel of not greater than one on twenty-four. Surfaces where bar seals are attached shall be accurately machined to provide uniform bearing for the full contact dimensions. Top, side, and invert bar seals shall be firmly butted together at

the corners. Final machining of bar seals shall be performed after they are attached to the gate frame. Gate frames for a flush-bottom seal gates shall be provided with frame mounted flush bottom seal. The flush-bottom rubber seal shall be held in place by bronze or stainless steel retainers and corrosive resistant fasteners. The sealing pressure shall be variable by adjustment of wedges.

2.3.6 Sluice Gate Stem, Stem Couplings and Stem Guides

Stems shall be manufactured from stainless steel and shall be of a size to safely withstand axial compression and tensile forces during gate operation under specified unbalanced heads. Stem composed of two or more sections shall be joined by a threaded coupling with key, simultaneously engaging the coupling and both stems. Stem guides shall be heavy duty castings with bronze bushings. Guides shall be fully adjustable and shall be properly spaced to support the stem as a long column. Stem guide mounting brackets shall be of sufficient strength to prevent twisting or sagging under load.

2.3.7 Shop Assembly

Shop assembly requirements for gate, gate frame and appurtenant items shall be as shown and as specified and in Section 05101 METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS. Gate, frame, guides, and appurtenant items shall be assembled completely in the shop to assure satisfactory field installation. The matchmarking of unassembled components shall be carefully preserved until the components are assembled. Adequate support shall be provided during assembly to maintain components within 1/16 inch of actual installation planes. Mating surfaces and machined surfaces shall be coated with a rust preventive coating until assembled. Other connecting surfaces which are not required to be disassembled for shipment shall be thinly coated with an approved rust preventive coating before being joined. Adjoining components shall be fitted and bolted together to facilitate field connections. Shop assembled components shall be delivered assembled, if practically permitted by shipping and field installation conditions. Assembled components shall be shop welded in their final positions as much as delivery and field installation conditions allow. Shop assembly and disassembly work shall be performed in the presence of the Contracting Officer unless otherwise approved. The presence of the Contracting Officer will not relieve the Contractor of any responsibility under this contract.

2.4 TESTS, INSPECTIONS, AND VERIFICATIONS

Tests, inspections, and verifications for materials and fabricated items shall conform to the requirements specified and in Section 05101 METALWORK FABRICATION, MACHINE WORK, AND MISCELLANEOUS PROVISIONS.

2.4.1 Testing of Rubber Seals

The fluorocarbon film of rubber seals shall be tested for adhesion bond in accordance with ASTM D 413 using either the machine method or the deadweight method. A 1 inch long piece of seal shall be cut from the end of the seal which has been masked and subjected to tension at an angle approximately 90 degrees to the rubber surface. There shall be no separation between the fluorocarbon film and the rubber when subjected to the following loads:

THICKNESS OF FLUOROCARBON FILM	MACHINE METHOD AT 2 INCHES PER MINUTE	DEADWEIGHT METHOD
0.030 inch	30 lbs per inch width	30 lbs per inch width
0.060 inch	30 lbs per inch width	30 lbs per inch width

2.4.2 Inspection

Shop assembled components shall be inspected for accurate fit and compliance with dimensional tolerances. Sealing, guiding, and connecting surfaces shall be inspected to determine if their planes are true, parallel, and in uniform contact with opposing surfaces.

2.4.3 Operation Tests

The operation of the shop-assembled gate assembly shall be tested by opening and closing the gate several times by use of the operating machinery. The force used to operate the gate shall be the minimum required to open and close the gate. Since the flush bottom seal of the gate frame is not fully supported during the operation tests, special precaution shall be taken to prevent the application of excessive force on the gate and frame when the gate is closed. Adjustments shall be made as required until operations are satisfactory.

PART 3 EXECUTION

3.1 INSTALLATION

Installation shall conform with the requirements specified and in Section 05101 METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS. Gate and appurtenant items shall be assembled for installation in strict accordance with the contract drawings, approved installation drawings, and shop match-markings. Bearing surfaces requiring lubrication shall be thoroughly cleaned and lubricated with an approved lubricant before assembly and installation. Components to be field welded shall be in correct alignment before welding is commenced.

3.1.1 Embedded Metals

Wall thimbles, bases, and other embedded metal items shall be accurately installed to the alignment and grade required to ensure accurate fitting and matching of components. Shims, jackbolts, or other supports required to align and hold components rigidly in place until embedment concrete has attained the specified strength shall be provided. Anchors shall be installed as shown. Embedded metals shall be given a primer coat of the required paint on all surfaces prior to installation in concrete forms. Items

requiring two concrete pours for installation shall be attached to the embedded anchors after the initial pour, adjusted to the proper alignment, and concreted in place with the second pour.

3.1.2 Square Wall Thimble

The wall thimble front face shall serve as the reference plane for the installation alignment. Alignment shall be to two theoretical control planes described as control plane "A" and control plane "B". Control plane "A" is a vertical plane that is normal to the water passageway and is located at the sealing surface of the gate frame seal bars. Control plane "B" is a vertical plane that is parallel to the water passageway and is located at the centerline of the water passageway. The wall thimble shall be aligned to within 0.015 inch of control planes "A" and "B". A taut piano wire and an electric micrometer or some other approved method shall be used to measure the vertical alignment tolerances. The wall thimble shall be internally braced during concrete placement to prevent warping. The threaded holes shall be plugged during concrete placement to prevent intrusion of the threaded area.

3.1.3 Sluice Gate, Sluice Gate Frame and Guides

The gate shall be attached to the gate frame as complete unit prior to installation. The gate shall be completely assembled, including the attachment of all components and accessories, prior to being placed in the gate frame. All necessary precautions shall be taken to avoid distortion of the gate and attached components during installation. The face of the wall thimble and mounting face of the sluice gate frame shall be thoroughly cleaned prior to installation. Mastic or a rubber gasket of uniform thickness shall be used to form a seal between the front face of the thimble and the back of the gate frame. Gate frame shall be connected to the wall thimble using corrosive resistant studs and fasteners. The vertical alignment of the gate frame shall be held to the same tolerance as stated for the wall thimble. Gate frame and guides shall be tested for proper alignment and clearances by lowering and raising the gate through the full operating range.

3.1.4 Flush-Bottom Seal

Gates with a flush-bottom seal shall have a rubber seal attached to the invert of the gate frame with bronze or stainless steel retainers and corrosive resistant fasteners. The top surface of the rubber seal shall be installed at the same elevation as the invert of the gate opening. The block out beneath the gate seal shall be filled with grout and leveled to the adjacent floor.

3.1.5 Sluice Gate Stem, Stem Couplings and Stem Guides

The gate stem shall be installed in vertical alignment within 1/8 inch per each 10 feet of distance. Stem guides shall be installed on anchors and spaced according to installation drawings to maintain vertical stem alignment. Care shall be taken when handling and installing stems as to prevent nicks or burrs in threads. Stem couplings shall be installed in proper order from bottom to top to place splices in correct location so that they will not interfere with the stem guides when the gate is opened or closed.

3.1.6 Operating Machinery

Operating machinery for the gate assembly and supporting components, including pedestal, and base plate, shall be positioned and aligned to the installed location of the gate frame and guides and anchored in place. The location of the sluice gate stem shall be projected to and scribed on the sill of the installed gate frame to serve as a reference point for the alignment of operating machinery and supporting components. Operating machinery and components shall be aligned to within 0.030 inch of the reference point.

3.1.7 Concrete and Concrete Grout Placement

The embedment of the wall thimble and other components in concrete shall be performed in an approved manner to fill all voids, secure anchorage, prevent seepage, and provide uniform finish surfaces. After embedment concrete has cured for at least 7 days, any voids around embedded components shall be filled by pumping concrete grout around the components. After the pumped grout has cured for at least 7 days, hammer blows to the components shall be used to detect any remaining voids. Where remaining voids are located, 1 inch diameter grout holes shall be drilled in the components and the voids shall be filled by pressure grouting through the grout holes. Grout holes in the components shall be plugged by welding and shall be ground flush.

3.1.8 Painting

Exposed parts of the gate and appurtenance components, except machined surfaces, corrosion-resistant surfaces, surfaces of anchorages embedded in concrete, and other specified surfaces, shall be painted as specified in Section 09940 PAINTING: HYDRAULIC STRUCTURES.

3.2 ACCEPTANCE TRIAL OPERATION AND TESTS

After the gate assembly has been installed, including operating machinery, the Contracting Officer will examine the complete system for final acceptance. Operation and test results shall be furnished to the Contracting Officer. The assembly will be examined first to determine whether or not the workmanship conforms to the specification requirements. The Contractor shall operate the gate throughout its full operating range a sufficient number of times to demonstrate proper operation. The initial operation of the gate assembly shall be conducted in the dry. The second trial operation and testing of the gate assembly shall be conducted with the reservoir normal operating pool hydrostatic pressure. The workmanship in the fabrication and installation of the gate assembly shall be such that the gate shall form a watertight barrier when lowered to the seated position. Adjustments shall be made to the operation and control apparatus until all components function as required. The actuator and other appurtenances will be inspected to assure proper operation. Required repairs or replacements to correct defects, as determined by the Contracting Officer, shall be made at no additional cost to the Government. The trial operation and testing shall be repeated after defects are corrected.

3.3 PROTECTION OF FINISHED WORK

Protection of finished work shall conform to the requirements of Section 05101 METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS.

End of Section

DIVISION 5 - METALS

SECTION 05915

STOPLOGS

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SECTION 05915

STOPLOGS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 36/A 36M	(1996) Carbon Structural Steel
ASTM A 307	(1994) Carbon Steel Bolts and Studs, 60 000 psi Tensile Strength
ASTM A 325	(1997) Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM D 395	(1997) Rubber Property - Compression Set
ASTM D 412	(1998) Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers - Tension
ASTM D 471	(1997) Rubber Property - Effect of Liquids
ASTM D 572	88(1994)e1 Rubber - Deterioration by Heat and Oxygen
ASTM D 2240	(1997) Rubber Property - Durometer Hardness

1.2 SUBMITTALS

Government approval is required for all submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Sequencing and Scheduling; GA.

Sequencing and scheduling plan shall be submitted and approved before the work is commenced.

SD-04 Drawings

Detail Drawings; GA.

Detail drawings shall be submitted as specified in Section 05101 METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS.

SD-07 Schedules

Materials; FIO.

Materials orders, materials lists and materials shipping bills shall be submitted as specified in Section 05101 METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS.

SD-08 Statements

Welding; GA.

Schedules of welding procedures for structural steel shall be submitted as specified in Section 05101 METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS.

SD-09 Reports

Tests, Inspections, and Verifications; FIO.

Certified test reports for material tests shall be submitted with all materials delivered to the site.

SD-18 Records

Materials Disposition Records; FIO.

A system of identification which shows the disposition of specific lots of approved materials and fabricated items in the work shall be established and submitted before completion of the contract.

1.3 QUALIFICATION OF WELDERS AND WELDING OPERATORS

Qualification of welders and welding operators shall conform to the requirements of Section 05101 METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS.

1.4 DELIVERY, STORAGE AND HANDLING

Delivery, handling and storage of materials and fabricated items shall conform to the requirements specified herein and in Section 05101 METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS.

1.4.1 Rubber Seals

Rubber seals shall be stored in a place which permits free circulation of air, maintains a temperature of 70 degrees F or less, and prevents the rubber from being exposed to the direct rays of the sun. Rubber seals shall be kept free of oils, grease, and other materials which would deteriorate the rubber. Rubber seals shall not be distorted during handling.

PART 2 PRODUCTS

2.1 MATERIALS

Materials orders, materials lists and materials shipping bills shall conform to the requirements of Section 05101 METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS.

2.1.1 Metals

Structural steel and other metal materials sections and standard articles shall be as shown and as specified.

2.1.2 Structural Steel

Structural steel shall conform to ASTM A 36/A 36M.

2.1.3 Rubber Seals

Rubber seals shall be compounded of natural rubber, synthetic polyisoprene, or a blend of both, and shall contain reinforcing carbon black, zinc oxide, accelerators, antioxidants, vulcanizing agents, and plasticizers. Physical characteristics of the seals shall meet the following requirements:

<u>PHYSICAL TEST</u>	<u>TEST VALUE</u>	<u>TEST METHOD SPECIFICATION</u>
Tensile Strength	2,500 psi (min.)	ASTM D 412
Elongation at Break	450% (min.)	ASTM D 412
300% Modulus	900 psi (min.)	ASTM D 412
Durometer Hardness (Shore Type A)	60 to 70	ASTM D 2240
*Water Absorption	5% by weight (max.)	ASTM D 471
Compression Set	30% (max.)	ASTM D 395
Tensile Strength (after aging 48 hrs)	803500f tensile strength (min.)	ASTM D 572

* The "Water Absorption" test shall be performed with distilled water. The washed specimen shall be blotted dry with filter paper or other absorbent material and suspended by means of small glass rods in the oven at a temperature of 70 degrees plus/minus 2 degrees C for 22 plus/minus 1/4 hour. The specimen shall be removed, allowed to cool to room temperature in air, and weighed. The weight shall be recorded to the nearest 1 mg as W1 (W1 is defined in ASTM D 471). The immersion temperature shall be 70 degrees plus/minus 1 degree C and the duration of immersion shall be 166 hours.

2.2 MANUFACTURED UNITS

Bolts, nuts, washers, screws and other manufactured units shall conform to the requirements.

2.2.1 Bolts, Nuts and Washers

High-strength bolts, nuts, and washers shall conform to ASTM A 325, hot-dip galvanized. Bolts, nuts, studs, stud bolts and bolting materials other than high-strength shall conform to ASTM A 307, Grade A, hot-dip galvanized. Bolts 1/2 inch and larger shall have hexagon heads. The finished shank of bolts shall be long enough to provide full bearing. Washers for use with bolts shall conform to the requirements specified in the applicable specification for bolts.

2.2.2 Screws

Screws shall be of the type indicated.

2.3 FABRICATION

2.3.1 Detail Drawings

Detail drawings of stoplogs and appurtenant shop fabricated items, including fabrication drawings, shop assembly drawings, delivery drawings, and field installation drawings, shall conform to the requirements specified and in Section 05101 METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS.

2.3.2 Fabrication Drawings

Fabrication drawings shall show complete details of materials, tolerances, connections, and proposed welding sequences which clearly differentiate shop welds and field welds.

2.3.3 Shop Assembly Drawings

Shop assembly drawings shall provide details for connecting the adjoining fabricated components in the shop to assure satisfactory field installation.

2.3.4 Delivery Drawings

Delivery drawings shall provide descriptions of methods of delivering components to the site, including details for supporting fabricated components during shipping to prevent distortion or other damages.

2.3.5 Field Installation Drawings

Field installation drawings shall provide a detailed description of the field installation procedures. The description shall include the location and method of support of installation and handling equipment; provisions to be taken to protect concrete and other work during installation; method of maintaining components in correct alignment; and methods for installing appurtenant items.

2.3.6 Structural Fabrication

Structural fabrication shall conform to the requirements specified and in Section 05101 METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS.

2.3.7 Welding

Welding shall conform to the requirements specified in Section 05101 METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS.

2.3.8 Bolted Connections

Bolted connections shall conform to the requirements specified in Section 05101 METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS.

2.3.9 Machine Work

Machine work shall conform to the requirements specified in Section 05101 METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS.

2.3.10 Miscellaneous Provisions

Miscellaneous provisions for fabrication shall conform to the requirements specified and in Section 05101 METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS.

2.3.11 Fabrications

2.3.12 Stoplogs

Stoplogs shall be fabricated of structural steel conforming to ASTM A 36/A 36M. Steel items shall be galvanized where indicated. The Contractor shall furnish all other materials and equipment as required for fabrication.

2.3.13 Stoplog Guides

Stoplog guides shall be fabricated of structural steel conforming to ASTM A 36/A 36M.

2.3.14 Miscellaneous Embedded Metals

Corner protection angles, frames, base plates, and other embedded metal items required for complete installation shall conform to the details shown.

2.3.15 Seal Assemblies

Seal assemblies shall consist of rubber seals, stainless steel retainer and spacer bars, and fasteners. Rubber seals shall be continuous over the full length. Seals shall be accurately fitted and drilled for proper installation. Bolt holes shall be drilled in the rubber seals by using prepared templates or the retainer bars as templates. Splices in seals shall be fully molded, develop a minimum tensile strength of 50 percent of the unspliced seal, and occur only at locations shown. All vulcanizing of splices shall be done in the shop. The vulcanized splices between molded corners and straight lengths shall be located as close to the corners as practicable. Splices shall be on a 45 degree bevel related to the

"thickness" of the seal. The surfaces of finished splices shall be smooth and free of irregularities. Stainless steel retainer bars shall be field-spliced only where shown and machine-finished after splicing.

2.4 TESTS, INSPECTIONS, AND VERIFICATIONS

Tests, inspections, and verifications for materials shall conform to the requirements specified in Section 05101 METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS.

PART 3 EXECUTION

3.1 INSTALLATION

Installation shall conform to the requirements specified and in Section 05101 METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS.

3.1.1 Embedded Metals

Corner protection angles, frames, base plates, and other embedded metal items required for complete installation shall be accurately installed to the alignment and grade required to ensure accurate fitting and matching of components. Embedded metals shall be given a primer coat of the required paint on all surfaces prior to installation in concrete forms. Anchors for embedded metals shall be installed as shown. Items requiring two concrete pours for installation shall be attached to the embedded anchors after the initial pour, adjusted to the proper alignment, and concreted in place with the second pour.

3.1.2 Seal Assemblies

Rubber seal assemblies shall be installed after the embedded metal components have been concreted in place and the gate installation, including painting, completed. Rubber seals shall be fastened securely to metal retainers. Before operating the gates, a suitable lubricant shall be applied to the rubber seal rubbing plates to protect the rubber.

3.1.3 Painting

Exposed parts of stoplogs and appurtenances except machined surfaces, corrosion-resistant surfaces, surfaces of anchorages embedded in concrete, rubber seals, and other specified surfaces shall be painted as specified in Section 09940 PAINTING: HYDRAULIC STRUCTURES.

3.2 PROTECTION OF FINISHED WORK

Protection of finished work shall conform to the requirements specified in Section 05101 METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS.

3.3 ACCEPTANCE TRIAL OPERATION

After completion of installation, the Contracting Officer will examine the stoplog installation for final acceptance. The individual components of the stoplog installation will be examined first to determine whether or not the workmanship conforms to the specification requirements. The Contractor will be required to place the stoplogs in the guides a sufficient number of times to demonstrate that the

stoplogs fit properly and seat uniformly. Required repairs or replacements to correct defects, shall be made at no cost to the Government. The trial operation shall be repeated after defects are corrected.

End of Section

DIVISION 6 - WOOD AND PLASTIC

SECTION 06100

ROUGH CARPENTRY

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SECTION 06100

ROUGH CARPENTRY

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN FOREST AND PAPER ASSOCIATION (AFPA)

AFPA-T901 (1991; Supple 1993; Addenda Apr 95) National Design Specification for Wood Construction

AFPA T11-WCD1 (1988) Manual for Wood Frame Construction

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM F 547 77(1995) Definitions of Terms Relating to Nails for Use with Wood and Wood-Base Materials

AMERICAN WOOD-PRESERVERS' ASSOCIATION (AWPA)

AWPA C2 (1998) Lumber, Timber, Bridge Ties and Mine Ties - Preservative Treatment by Pressure Processes

AWPA M4 (1998) Standard for the Care of Preservative-Treated Wood Products

AWPA P5 (1998) Standards for Waterborne Preservatives

FACTORY MUTUAL ENGINEERING AND RESEARCH (FM)

FM P7825c (1997) Approval Guide Building Materials

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-04 Drawings

Nailers and Nailing Strips; GA.

Drawings of field erection details, including materials and methods of fastening nailers in conformance with Factory Mutual wind uplift rated systems specified in other Sections of these specifications.

SD-13 Certificates

Grading and Marking; FIO.

Manufacturer's certificates (approved by an American Lumber Standards approved agency) attesting that lumber and material not normally grade marked meet the specified requirements. Certificate of Inspection for grade marked material by an American Lumber Standards Committee (ALSC) recognized inspection agency prior to shipment.

1.3 DELIVERY AND STORAGE

Materials shall be delivered to the site in undamaged condition, stored off ground in fully covered, well ventilated areas, and protected from extreme changes in temperature and humidity.

PART 2 PRODUCTS

2.1 LUMBER AND SHEATHING

2.1.1 Grading and Marking

2.1.1.1 Lumber Products

Solid sawn and finger-jointed lumber shall bear an authorized gradestamp or grademark recognized by ALSC, or an ALSC recognized certification stamp, mark, or hammerbrand. Surfaces that are to be exposed to view shall not bear grademarks, stamps, or any type of identifying mark. Hammer marking will be permitted on timbers when all surfaces will be exposed to view.

2.1.2 Sizes

Lumber and material sizes shall conform to requirements of the rules or standards under which produced. Unless otherwise specified, lumber shall be surfaced on four sides. Unless otherwise specified, sizes indicated are nominal sizes, and actual sizes shall be within manufacturing tolerances allowed by the standard under which the product is produced.

2.1.3 Treatment

Exposed areas of treated wood that are cut or drilled after treatment shall receive a field treatment in accordance with AWWA M4. Items of all-heart material of cedar, cypress, or redwood will not require preservative treatment, except when in direct contact with soil. Except as specified for all-heart material of the previously mentioned species, the following items shall be treated:

- a. Wood members in contact with or within 18 inches of soil.
- b. Wood members in contact with water.
- c. Wood members exposed to the weather including those used in built-up roofing systems or as nailing strips or nailers over fiberboard or gypsum-board wall sheathing as a base for wood siding.

- d. Wood members set into concrete regardless of location, including flush-with-deck wood nailers for roofs.
- e. Wood members in contact with concrete that is in contact with soil or water or that is exposed to weather.

2.1.3.1 Lumber and Timbers

Lumber and timbers shall be treated in accordance with AWWA C2 with waterborne preservatives listed in AWWA P5 to a retention level as follows:

- a. 0.25 pcf intended for above ground use.
- b. 0.40 pcf intended for ground contact and fresh water use.

2.1.4 Moisture Content

At the time lumber and other materials are delivered and when installed in the work their moisture content shall be as follows:

- a. Treated and Untreated Lumber Except Roof Planking:
4 inches or less, nominal thickness, 19 percent maximum. 5 inches or more, nominal thickness, 23 percent maximum in a 3 inch perimeter of the timber cross-section.

2.1.5 Miscellaneous Wood Members

2.1.5.1 Nonstress Graded Members

Members shall include bridging, corner bracing, furring, grounds, and nailing strips. Members shall be in accordance with TABLE I for the species used. Sizes shall be as follows unless otherwise shown:

<u>Member</u>	<u>Size (inch)</u>
Nailing strips	1 x 3 or 1 x 4 when used as shingle base or interior finish, otherwise 2 inch stock.

2.1.5.2 Blocking

Blocking shall be standard or number 2 grade.

2.1.5.3 Rough Bucks and Frames

Rough bucks and frames shall be straight standard or number 2 grade.

2.2 ACCESSORIES AND NAILS

Markings shall identify both the strength grade and the manufacturer. Accessories and nails shall conform to the following:

2.2.1 Bolts: Lag, Toggle, and Miscellaneous Bolts and Screws

Type, size, and finish best suited for intended use. Finish options include zinc compounds, cadmium, and aluminum paint impregnated finishes.

2.2.2 Nails and Staples

ASTM F 547, size and type best suited for purpose; staples shall be as recommended by the manufacturer of the materials to be joined. For sheathing and subflooring, length of nails shall be sufficient to extend 1 inch into supports. In general, 8-penny or larger nails shall be used for nailing through 1 inch thick lumber and for toe nailing 2 inch thick lumber; 16-penny or larger nails shall be used for nailing through 2 inch thick lumber. Nails used with treated lumber and sheathing shall be galvanized. Nailing shall be in accordance with the recommended nailing schedule contained in AFPA T11-WCD1. Where detailed nailing requirements are not specified, nail size and spacing shall be sufficient to develop an adequate strength for the connection. The connection's strength shall be verified against the nail capacity tables in AFPA-T901. Reasonable judgement backed by experience shall ensure that the designed connection will not cause the wood to split. If a load situation exceeds a reasonable limit for nails, a specialized connector shall be used.

PART 3 EXECUTION

3.1 INSTALLATION OF MISCELLANEOUS WOOD MEMBERS

3.1.1 Blocking

Blocking shall be provided as necessary for application of siding, sheathing, subflooring, wallboard, and other materials or building items, and to provide firestopping. Blocking for firestopping shall ensure a maximum dimension of 8 feet for any concealed space. Blocking shall be cut to fit between framing members and rigidly nailed thereto.

3.1.2 Nailers and Nailing Strips

Nailers and nailing strips shall be provided as necessary for the attachment of finish materials. Nailers used in conjunction with roof deck installation shall be installed flush with the roof deck system. Stacked nailers shall be assembled with spikes or nails spaced not more than 18 inches on center and staggered. Beginning and ending nails shall not be more than 6 inches for nailer end. Ends of stacked nailers shall be offset approximately 12 inches in long runs and alternated at corners. Anchors shall extend through the entire thickness of the nailer. Strips shall be run in lengths as long as practicable, butt jointed, cut into wood framing members when necessary, and rigidly secured in place. Nailers and nailer installation for Factory Mutual wind uplift rated roof systems specified in other Sections of these specifications shall conform to FM P7825c.

3.1.3 Rough Bucks and Frames

Rough bucks shall be set straight, true, and plumb, and secured with anchors near top and bottom of each wood member and at intermediate intervals of not more than 3 feet. Anchors for concrete shall be expansion bolts, and anchors for masonry shall be 3/16 x 1-1/4 inch steel straps extending not less than 8 inches into the masonry and turned down 2 inches into the masonry.

TABLE I. SPECIES AND GRADE

Subflooring, Roof Sheathing, Wall Sheathing, Furring

Grading Rules	Species	Const Standard	No. 2 Comm	No. 2 Board Comm	No. 3 Comm
<hr/>					
SPIB-1001					
	Southern Pine		X		
WCLIB Std 17					
	Douglas Fir-Larch	X			
	Hem-Fir	X			
	Sitka Spruce	X			
	Mountain Hemlock	X			
	Western Cedar	X			
WWPA-01					
	Douglas Fir-Larch	X			
	Hem-Fir	X			
	Idaho White Pine	X			
	Lodgepole Pine		X		
	Ponderosa Pine		X		
	Sugar Pine		X		
	Englemann Spruce		X		
	Douglas Fir South		X		
	Mountain Hemlock		X		
	Subalpine Fir		X		
	Western Cedar		X		

End of Section

DIVISION 7 - THERMAL AND MOISTURE PROTECTION

SECTION 07220

ROOF INSULATION

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SECTION 07220

ROOF INSULATION

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A208.1 (1993) Particleboard

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 578 (1995) Rigid, Cellular Polystyrene Thermal Insulation

ASTM C 726 (1993) Mineral Fiber Roof Insulation Board

ASTM C 728 (1997) Perlite Thermal Insulation Board

ASTM C 1050 (1991) Rigid Cellular Polystyrene - Cellulosic Fiber Composite Roof Insulation

ASTM C 1289 (1998) Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board

ASTM D 41 (1994) Asphalt Primer Used in Roofing, Damp-proofing, and Waterproofing

ASTM D 226 (1997a) Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing

ASTM D 312 (1995a) Asphalt Used in Roofing

ASTM D 2178 (1997a) Asphalt Glass Felt Used in Roofing and Waterproofing

ASTM D 4586 (1993) Asphalt Roof Cement, Asbestos Free

ASTM D 4897 (1997a) Asphalt-Coated Glass-Fiber Venting Base Sheet Used in Roofing

ASTM F 547 77(1995) Terminology of Nails for Use with Wood and Wood-Base Materials

FACTORY MUTUAL ENGINEERING AND RESEARCH (FM)

FM P7825

(1995; Supple I; Supple II; Supple III) Approval Guide

UNDERWRITERS LABORATORIES (UL)

UL-01

(1996) Building Materials Directory

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-06 Instructions

Application of Insulation; GA.

Insulation manufacturer's recommendations for the application and installation of insulation.

SD-08 Statements

Inspection; GA.

The inspection procedure for insulation installation, prior to start of roof insulation work.

SD-13 Certificates

Insulation; GA. Glass Roofing Felt; GA. Organic Roofing Felt; GA.

Certificate attesting that the expanded perlite or polyisocyanurate insulation contains recovered material and showing estimated percent of recovered material. Certificates of compliance for felt materials.

1.3 STORAGE OF MATERIALS

Extruded polystyrene shall be stored in accordance with manufacturer's instructions. Other insulation, base sheet, and felt shall be kept dry at all times, before, during, and after delivery to the site and shall be stored in an enclosed building or in a closed trailer. Wet insulation, wet base sheet or wet felt shall be permanently removed from the site. Felts shall be stacked on end one level high. Felt rolls shall be maintained at a temperature above 50 degrees F for 24 hours immediately before laying.

PART 2 PRODUCTS

2.1 BITUMINOUS MATERIALS

Bituminous materials shall conform to the following requirements:

2.1.1 Asphalt Bitumen

ASTM D 312, Type III or IV. Asphalt flash point, finished blowing temperature, and equiviscous temperature (EVT) shall be indicated on bills of lading or on individual containers.

2.1.2 Asphalt Cement

ASTM D 4586, Type I for horizontal surfaces; Type II for vertical surfaces.

2.1.3 Asphalt Primer

ASTM D 41.

2.2 INSULATION

Insulation shall be a standard product of the manufacturer and shall be factory marked with the manufacturer's name or trade mark, the material specification number, the R-value at 75 degrees F, and the thickness. Minimum thickness shall be as recommended by the manufacturer. Boards shall be marked individually. The thermal resistance of insulation shall be not less than the R-value shown on the drawings. The insulation manufacturing process shall not include chlorofluoro carbons (CFC) or formaldehydes. Insulation and fiberboard shall contain the highest practicable percentage of material which has been recovered or diverted from solid waste (e.g., post-consumer waste), but not including material reused in a manufacturing process. Where two materials have comparable price and performance, the one having the higher recovered material content shall be selected. Insulation shall be one, or a combination of the following materials:

2.2.1 Composite Board Insulation

ASTM C 726, or ASTM C 1050 or ASTM C 1289 Type III, or ASTM C 1289 Type VI. Perlite, in composite board, may be replaced with ANSI A208.1 wood particle board, 7/16 inch minimum thickness, provided that the composite board meets specified physical requirements. Composite board with wood particle board shall conform to ASTM C 1289, Type V.

2.2.2 Expanded-Perlite Insulation Board

ASTM C 728 with a minimum recovered material content of 23 percent of the expanded perlite portion of the board.

2.2.3 Polystyrene

ASTM C 578, Type II, IV, or X.

2.3 NAILS AND FASTENERS

Nails and fasteners shall conform to the following requirements:

2.3.1 Nails for Fastening Insulation to Flush Mounted Wood Nailers

ASTM F 547 of sufficient length to hold insulation securely in place.

2.3.2 Fasteners

Insulation manufacturer's recommendations. Fasteners for steel or concrete decks shall conform to FM P7825 for Class I roof deck construction, and shall be spaced to withstand an uplift pressure of 60 pounds per square foot.

2.3.3 Metal Disks

Flat and not less than 30 gauge thickness. Disks used with nails or fasteners for securing fiberboard insulation shall be minimum 1 inch diameter. Disks used with nails or fasteners for securing other board insulation shall be minimum 2-1/8 inches in diameter.

2.4 VENTING INORGANIC BASE SHEET

ASTM D 4897, Type II, Non-perforated, with spot mopping holes where specified.

2.5 GLASS ROOFING FELT

ASTM D 2178, Type IV.

2.6 ORGANIC ROOFING FELT

ASTM D 226, Type I.

2.7 WOOD NAILERS

Wood nailers shall conform to Section 06100 ROUGH CARPENTRY including preservative treatment. Edge nailers shall be not less than nominal 6 inches wide and of thickness to finish flush with the top surface of the insulation. Surface mounted nailers shall be a nominal 3 inches wide by the full thickness of the insulation.

PART 3 EXECUTION

3.1 COORDINATION REQUIREMENTS

Insulation and roofing membrane shall be finished in one operation up to the line of termination at the end of each day's work. Completed sections shall be waterproofed when more than one day is required to finish the roofing. Phased construction will not be permitted.

3.2 ENVIRONMENTAL CONDITIONS

Air temperature shall be above 40 degrees F and there shall be no visible ice, frost, or moisture on the roof deck when the insulation and roofing are installed.

3.3 SUBSTRATE PREPARATION

The substrate construction of any bay or section of the building shall be completed before insulation or vapor retarder work is begun thereon. Insulation or vapor retarder applied directly on concrete shall not be scheduled until frothing or bubbling does not occur when hot bitumen is applied to the concrete and until the hot bitumen sticks tightly to the concrete. Vents and other items penetrating the roof shall be secured in position and properly prepared for flashing. Prior to application of vapor retarder or

insulation, substrate joints shall be covered with a 4 inch strip of roofing felt, embedded in and coated with asphalt cement. Substrate surface shall be smooth, clean, and dry at time of application.

3.4 HEATING OF ASPHALT

Asphalt shall not be heated higher than 75 degrees F above the EVT or 50 degrees F below the flash point, or 525 degrees F, whichever is lower. EVT and flash point temperatures of asphalt in the kettle shall be conspicuously posted on the kettle. Kettle shall be provided with automatic thermostatic controls and an accurate thermometer. Kettle operators shall be in attendance at all times during heating to ensure that the maximum temperature is not exceeded. Asphalt shall be applied within a range of 25 degrees F below or above the EVT, or as specified by the manufacturer. Application temperature shall be measured at the mop bucket or mechanical applicator. Asphalt at a temperature below this range shall be returned to the kettle. Flame-heated equipment shall not be placed on the roof.

3.5 VAPOR RETARDER

3.5.1 General Application

Vapor retarder shall consist of two plies of roofing felt, mopped at right angle to the slope, with 6 inch end laps staggered at least 12 inches. The full 19 inch starter ply and full 36 inch wide ply sheets shall be placed, in succession, in hot asphalt immediately behind the applicator. Each ply shall be solid mopped in not less than 20 nor more than 30 pounds of asphalt per square. A squeegee shall be used with glass felts and a broom shall be used with organic felts to embed the felts, eliminate air pockets and obtain adhesion between the plies. Side and end laps shall be completely sealed. Asphalt shall be visible beyond all edges of each ply as it is being installed. Plies shall be laid free of wrinkles, creases or fishmouths. Workers shall not walk on mopped surfaces when the asphalt is sticky. For slopes exceeding 1/2 inch per foot, each ply shall be nailed 2 and 6 inches from the upper edge with nails spaced 12 inches on centers and staggered in each row.

3.5.2 Edge Requirements

At walls, eaves and rakes, the vapor retarder organic felts shall be extended 9 inches, or separate organic felt plies shall be extended 9 inches, with not less than 9 inches on the substrate, and the extended portion turned back and mopped in over the top of the vapor retarder. At roof penetrations other than walls, eaves and rakes, the vapor retarder or separate plies shall be extended 9 inches to form a lap which shall later be folded back over the edge of the insulation. Asphalt roof cement shall be used under the vapor retarder for at least 9 inches from walls, eaves, rakes and other penetrations.

3.5.3 Over Concrete Decks and First Layer of Insulation on Steel Decks

The 2-ply vapor retarder shall be applied as specified above except that venting inorganic base sheet shall be deleted.

3.6 INSTALLATION OF WOOD NAILERS

Nailers shall be secured to cast-in-place deck materials by not less than 3/8 inch diameter anchors embedded in the deck not over 4 feet on centers. Bolt anchors shall have nuts and washers countersunk, and bolts shall be cut flush with top of nailer. Powder-actuated fasteners, sized and spaced for nailer anchorage equivalent to that specified and indicated, may be used when approved. Surface mounted nailers shall be installed parallel with the roof slope and shall be spaced not over 4

feet face-to-face, except that where the insulation units are less than 4 feet in length the nailers shall be spaced to minimize cutting of the insulation.

3.7 APPLICATION OF INSULATION

Insulation shall be laid in two or more layers. Units of insulation shall be laid in courses parallel with the roof slope. End joints shall be staggered. Insulation shall be cut to fit neatly against adjoining surfaces. Joints between insulation boards shall not exceed 1/4 inch. Joints in successive layers shall be staggered with respect to joints of preceding layer. Insulation shall be applied so that all roof insulation applied each day is waterproofed the same day. Phased construction will not be permitted. Application of impermeable faced insulation shall be performed without damage to the facing.

3.7.1 Mechanical Fastening

On any slope exceeding 1/2 inch per foot, the first layer of insulation shall be mechanically fastened. Method of attachment shall be in accordance with recommendations of the insulation manufacturer and requirements specified.

3.7.2 Foam Insulation

Polystyrene foam insulation shall be isolated from built-up roof membrane by a separate or composite layer of cellular glass, mineral fiber board, perlite board, or fiberboard. Polystyrene shall not be exposed to solvent-base adhesive, coal-tar bitumen or to asphalt which is hotter than 200 degrees F.

3.7.3 Installation

Insulation layers shall be laid in solid moppings of hot asphalt applied at a rate of at least 20 pounds per square. Asphalt shall not be applied further than one panel length ahead of roof insulation being installed. Where roof slopes are greater than 1/2 inch per foot, roof insulation shall be held in place by both asphalt mopping and mechanical fasteners. Asphalt primer shall be applied at the rate of 1 gallon per square over the entire surface to be mopped when the insulation is applied over concrete deck. The edges of insulation boards adjoining vented nailers shall be kept free of asphalt.

3.7.4 Protection Requirements

The insulation shall be kept dry at all times. Insulation boards shall not be kicked into position. Exposed edges of the insulation shall be protected by cutoffs at the end of each work day or whenever precipitation is imminent. Cutoffs shall be 2 layers of bituminous-saturated felt set in plastic bituminous cement. Cutoffs shall be removed when work is resumed. Edges of insulation at open spaces between insulation and parapets or other walls and spaces at curbs, scuttles, and expansion joints, shall be protected until permanent roofing and flashing is applied. Storing, walking, wheeling, or trucking directly on insulation or on roofed surfaces will not be permitted. Smooth, clean board or plank walkways, runways, and platforms shall be used, as necessary to distribute weight to conform to a 20 pounds per square foot live load limit.

3.8 INSPECTION

The Contractor shall establish and maintain an inspection procedure to assure compliance of the installed roof insulation with the contract requirements. Any work found not to be in compliance with the contract shall be promptly removed and replaced or corrected in an approved manner. Quality control shall include, but not be limited to, the following:

- a. Observation of environmental conditions; number and skill level of insulation workers; start and end time of work.
- b. Verification of certification, listing or label compliance with FM P7825.
- c. Verification of proper storage and handling of insulation and vapor retarder materials before, during, and after installation.
- d. Inspection of vapor retarder application, including edge envelopes and mechanical fastening.
- e. Inspection of mechanical fasteners; type, number, length, and spacing.
- f. Coordination with other materials, cants, sleepers, and nailing strips.
- g. Inspection of insulation joint orientation and laps between layers, joint width and bearing of edges of insulation on deck.
- h. Installation of cutoffs and proper joining of work on subsequent days.
- i. Continuation of complete roofing system installation to cover insulation installed same day.

End of Section

DIVISION 7 - THERMAL AND MOISTURE PROTECTION

SECTION 07510

BUILT-UP ROOFING

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SECTION 07510

BUILT-UP ROOFING

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 208	(1995) Cellulosic Fiber Insulating Board
ASTM C 728	(1997) Perlite Thermal Insulation Board
ASTM C 1153	(1997) The Location of Wet Insulation in Roofing Systems Using Infrared Imaging
ASTM D 41	(1994) Asphalt Primer Used in Roofing, Damp-proofing, and Waterproofing
ASTM D 43	(1994) Coal Tar Primer Used in Roofing, Damp-proofing, and Waterproofing
ASTM D 226	(1997a) Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing
ASTM D 227	(1997a) Coal-Tar Saturated Organic Felt Used in Roofing and Waterproofing
ASTM D 312	(1995a) Asphalt Used in Roofing
ASTM D 450	(1996) Coal-Tar Pitch Used in Roofing, Damp-proofing, and Waterproofing
ASTM D 1668	(1997a) Glass Fabrics (Woven and Treated) for Roofing and Waterproofing
ASTM D 1863	(1996) Mineral Aggregate Used on Built-Up Roofs
ASTM D 2178	(1997a) Asphalt Glass Felt Used in Roofing and Waterproofing
ASTM D 2626	(1997b) Asphalt-Saturated and Coated Organic Felt Base Sheet Used in Roofing

ASTM D 3617	83(1994)e1 Sampling and Analysis of New Built-Up Roof Membranes
ASTM D 4022	(1994) Coal Tar Roof Cement, Asbestos Containing
ASTM D 4586	(1993) Asphalt Roof Cement, Asbestos Free
ASTM D 4601	(1997a) Asphalt-Coated Glass Fiber Base Sheet Used in Roofing
ASTM D 4897	(1997a) Asphalt-Coated Glass-Fiber Venting Base Sheet Used in Roofing

FACTORY MUTUAL ENGINEERING AND RESEARCH (FM)

FM-04	(1996) Approval Guide: Building Materials
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1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-08 Statements

Inspection; GA.

The inspection procedure for roofing installation, prior to the start of roofing work.

SD-13 Certificates

Bitumen; GA. Felt; GA.

Certificates of Compliance for felts and bitumens.

Cants; GA.

Certificate attesting that the fiberboard furnished for the project contains recovered material, and showing an estimated percent of such recovered material.

1.3 STORAGE OF MATERIALS

Felts, fabrics, and roll roofing shall be kept dry before, during, and after delivery to the site and shall be stored in an enclosed building or in a closed trailer, and stored on end 1 level high. Felt rolls shall be maintained at a temperature above 50 degrees F for 24 hours immediately before laying. Aggregate shall be kept dry as defined by ASTM D 1863.

PART 2 PRODUCTS

2.1 PRIMER

ASTM D 41 for asphalt roofing systems; ASTM D 43 for coal-tar roofing systems.

2.2 BITUMEN

2.2.1 Asphalt

ASTM D 312, Type II on slopes from 1/4 inch per foot up to and including 1/2 inch per foot. Bills of lading shall indicate the flash point and equiviscous temperature (EVT) or this information shall be shown on labels for each container of asphalt.

2.2.2 Coal-Tar Bitumen

ASTM D 450, Type III, for 1/4 inch per foot slope as an option to asphalt.

2.3 BITUMINOUS CEMENT

ASTM D 4586 for use with asphalt roofing systems. ASTM D 4022 for use with coal-tar roofing systems; preference shall be given to cements whose mineral fillers exclude asbestos fibers.

2.4 CANTS

Cants shall be made from treated wood or treated fiberboard not less than 3-1/2 inches high perlite or board cut to reduce change in direction of the membrane to 45 degrees or less. Treated wood shall be of water-borne preservative-treated material as specified in Section 06100 ROUGH CARPENTRY. Perlite and fiberboard shall contain the highest practicable percentage of materials which have been recovered or diverted from solid waste (e.g., post-consumer waste), but not including material reused in a manufacturing process. Where two materials have comparable price and performance, the one having the higher recovered material content shall be selected. Fiberboard shall conform to ASTM C 208 with a minimum recovered material content of 80 percent, treated with sizing, wax or bituminous impregnation. Perlite board shall conform to ASTM C 728 with a minimum recovered material content of 23 percent of the expanded perlite portion of the board.

2.5 FELT

2.5.1 Base Sheet

Base sheet shall conform to ASTM D 4601, Type II, with no perforations.

2.5.2 Venting Inorganic Base Sheet

ASTM D 4897, Type II.

2.5.3 Glass Roofing Felt

ASTM D 2178, Type IV or VI, except felts for coal tar systems shall be impregnated with a bituminous resin coating which is compatible with coal tar bitumen.

2.5.4 Organic Felt Base

ASTM D 2626 for use with asphalt roofing system.

2.5.5 Organic Felt

ASTM D 226 for use with asphalt roofing system and ASTM D 227 for use with coal-tar roofing system. Organic felts may be used for bitumen stops, and edge envelopes.

2.6 NAILS AND FASTENERS

Nails and fasteners shall be an approved type recommended by the roofing felt manufacturer. Fasteners for steel or concrete deck shall conform to FM-04 for Class I roof deck construction, to withstand an uplift pressure of 60 pounds per square foot.

2.7 AGGREGATE SURFACING MATERIALS

Crushed stone, gravel, or crushed slag conforming to ASTM D 1863. Subject to approval, other materials may be used when blended to the grading requirements of ASTM D 1863. Aggregate shall be light-colored and opaque.

2.8 WOVEN GLASS FABRIC

ASTM D 1668, Type I for asphalt roofing systems and Type II for coal-tar roofing systems.

2.9 INSULATION

Insulation shall be fiberboard, composite board, expanded perlite, mineral fiber, as specified in Section 07220 ROOF INSULATION. Top layer shall be minimum 3/4 inch thick fiberboard, mineral fiber or perlite.

2.10 FLASHINGS

Bituminous flashings in accordance with these specifications shall be used throughout unless otherwise specified or indicated.

PART 3 EXECUTION

3.1 COORDINATION

The entire roofing system, excluding flood coat and aggregate surfacing, shall be finished in 1 operation up to the line of termination at end of day's work. Glaze coating may be considered part of the flood coat as specified in paragraph GLAZE COAT. Phased construction will not be permitted.

3.1.1 Insulation

Application of roofing shall immediately follow application of insulation as a continuous operation. Roofing operations shall be coordinated with insulation work so that all roof insulation applied each day is waterproofed the same day. Insulation is specified in Section 07220 ROOF INSULATION.

3.1.2 Sheet Metalwork

Roofing operations shall be coordinated with sheet metalwork so that sheet metal items are installed to permit continuous roof surfacing operations the same day felts are installed. Sheet metalwork is specified in Section 07600 SHEET METALWORK, GENERAL.

3.2 ENVIRONMENTAL CONDITIONS

Air temperature shall be above 40 degrees F and there shall be no visible ice, frost, or moisture on the roof deck at the time roofing is installed.

3.3 PREPARATION REQUIREMENTS

The substrate construction of a bay or section of the building shall be completed before roofing work is begun thereon. Roofing applied directly on concrete shall not be scheduled until frothing or bubbling does not occur when hot bitumen is applied to the concrete and until the hot bitumen sticks tightly to the concrete. Vents and other items penetrating the roof shall be secured in position and properly prepared for flashing. Nailers, curbs and other items attached to roof surface shall be in place before roofing is begun.

3.4 INSTALLATION OF CANTS

Cants shall be installed in the angles formed between the roof and walls or other vertical surfaces. Cants shall be laid in a solid coat of bituminous cement just prior to laying the roofing plies. Cants shall be continuous, and shall be installed in lengths as long as practicable. Additional cants are not required at locations where cast-in-place cants are integrally formed with the structural deck or roof fill.

3.5 CONDITION OF SURFACES

Surfaces shall be inspected and approved immediately before application of roofing and flashings. The roofing and flashings shall be applied to a smooth and firm surface free from ice, frost, visible moisture, dirt, projections, and foreign materials. Prior to application of primer on precast concrete decks, joints shall be covered with a 4 inch strip of roofing felt, embedded in and coated with bituminous cement.

3.6 MECHANICAL APPLICATION DEVICES

Mechanical application devices shall be mounted on pneumatic-tired wheels, and shall be designed and maintained to operate without damaging the insulation, roofing membrane, or structural components.

3.7 PRIMING

Concrete surfaces to receive bitumen shall be uniformly coated with primer at a rate of not less than 1 gallon per square and allowed to dry. Primer shall be compatible with the bitumen to be used.

3.8 HEATING OF BITUMEN

Asphalt shall not be heated higher than 75 degrees F above the EVT or 50 degrees below the flash point or 525 degrees F (maximum) whichever is lower. EVT and flash point temperatures of asphalt in the kettle shall be conspicuously posted on the kettle. Coal tar bitumen shall not be heated above 425

degrees F or as recommended by the roofing manufacturer. Heating kettles shall be provided with automatic thermostatic controls and an accurate thermometer. Kettle operators shall be in attendance at all times during the heating to ensure that the maximum temperature specified is not exceeded. Equipment utilizing flame-heat shall not be placed on the roof.

3.9 BITUMEN STOPS

Bitumen stops shall be installed at roof edges, openings and vertical projections before application of roofing plies unless otherwise recommended by the manufacturer's printed instructions. Bitumen stops shall be formed of two 18 inch wide strips of organic felt. Nine inches of the width shall be attached to the roof surface with 9 inches extending beyond the edge. The first strip shall be applied in a 9 inch wide layer of bituminous roofing cement and nailed 1/2 inch from the roof edge at 6 inch spacing. The second strip shall be applied to the first in a 9 inch wide mopping of bitumen. The free portion of each strip shall be protected from damage throughout the roofing period. After the roofing plies are in place, the free portion of each strip shall be folded back over the roofing membrane and embedded in a continuous coating of bituminous cement and secured with roofing nails spaced 3 inches on centers.

3.10 BITUMEN APPLICATION

Asphalt shall be applied within a range of 25 degrees F below to 25 degrees F above the EVT. Temperature of coal-tar bitumen at the time it is applied shall be in accordance with the bitumen manufacturer's recommendations. Application temperatures shall be measured at the mop bucket or mechanical applicator. Bitumen at a temperature below the recommended temperature shall be returned to the kettle. Each layer of felt shall be laid in not less than 20 pounds nor more than 35 pounds of asphalt per square or not less than 30 pounds nor more than 35 pounds of coal-tar bitumen per square. Where solid moppings are required, the following requirements as evidenced in any one roof cut-out sample shall apply:

- a. Overlapping voids between two or more plies are not acceptable.
- b. The maximum length of any individual void that is encapsulated in bitumen shall be 2 inches.
- c. The total length of all voids encapsulated in bitumen shall not exceed 4 inches between any two plies.
- d. Dry voids (the absence of bitumen between plies) are not acceptable.
- e. Voids continuous through the specimen are not acceptable.
- f. Visual interply moisture in voids is not acceptable.

3.11 APPLICATION OF FELTS

Felt plies shall be laid at right angles to the slope of the deck with minimum 6 inch end-laps staggered at least 12 inches. Felts shall be applied in 36 inch widths with 24 2/3 inch side laps and starter sheets 12, 24 and 36 inches wide along eaves to maintain 4 full plies including the base sheet when used. The full 36 inch width of each ply shall be placed in hot bitumen immediately behind the applicator. A squeegee, broom or follow through tool shall be used to eliminate air pockets and obtain complete adhesion between plies. Bitumen shall be visible beyond all edges of each ply as it is being installed. Plies shall be laid free of wrinkles, creases or fishmouths. Each layer of roofing felt shall be carried up

to the top of the cant. Workers shall not walk on mopped surfaces when the bitumen is fluid. For slopes exceeding 1/2 inch per foot, each felt ply, other than venting base sheet, shall be nailed 2 inches and 6 inches from upper edge with nails spaced 12 inches on centers in each row.

3.11.1 On Concrete or Insulation Surfaces

Four plies of 36 inch wide glass roofing felts shall be placed shingle-fashion in solid mopped bitumen.

3.12 MECHANICAL FASTENING

Nails and fasteners for securing roofing shall be flush driven through flat metal disks of not less than 1 inch diameter. Metal disks may be omitted where heads of fasteners are equivalent in size to the 1 inch diameter disks. Fasteners, when required, shall be spaced within 20 percent of the indicated spacing dimensions. There shall be no less than the total number of indicated fasteners in any 100 square feet area. Fastener pull-out resistance shall be not less than 40 pounds each.

3.13 PROTECTION OF APPLIED ROOFING

At end of day's work or whenever precipitation is imminent, the terminated edge of built-up roofing shall be sealed with 2 full width strips of roofing felt set in and coated with bituminous cement. One half-width of the strips shall be extended up and over the finished roofing and the other half-width extended out and onto the bare roof deck. Sealing strips shall be removed before continuing installation of roofing. To facilitate sealing, termination edges may be straightened with pieces of insulation board which shall be removed when work is resumed.

3.14 FLASHINGS

Flashings shall be provided over cants in the angles formed at walls and other vertical surfaces and where required to make the work watertight. Bituminous flashings described below shall be used, except where metal flashings are specified in other sections of the specifications. Flashings shall be provided and installed immediately after the top ply of felt is placed and before the flood coat and aggregate are placed, adjacent to the flashing. Modified bituminous flashing may be used when it is specified in the roofing manufacturer's instructions.

3.14.1 Base Flashings

Base Flashings shall be a 3-ply system using woven glass fabric, laid in roofing cement, with mineral surfaced roll roofing as the outer ply. The top of the base flashing shall be at least 8 inches above the roof membrane surface. Mineral surfaced roofing strips shall be cut from the width of the rolls, and shall extend from the reglet or top of curb onto the roof at least 2 inches beyond the widest flashing ply. Laps shall be well cemented, and where possible, shall be shingled in a direction down slope or away from the prevailing wind. The top edge of base flashing systems shall be nailed a maximum of 8 inches on center.

3.14.2 Strip Flashings

Sheet metal flashings, bitumen stops and gravel stops installed over the roofing top ply shall be strip flashed with 2 layers of roofing felt, 9 inches and 12 inches wide and successively cemented in place.

3.14.3 Valleys and Ridges

Felt plies shall continue across valleys and ridges and terminate approximately 12 inches from the valley or ridge. Exposed lap shall terminate on a line approximately 12 inches from, and parallel to the valley or ridge. Two plies of roofing felt, 9 inch wide bottom ply, and 12 inch wide top ply, shall be successively mopped-in over each felt line of termination.

3.15 AGGREGATE SURFACING

After roofing felts have been laid and flashings installed, the roof surface, except for cants, shall be flood-coated uniformly with 60 pounds of hot asphalt per square or 75 pounds per square of coal-tar bitumen if coal-tar roof system is used. Aggregate surfacing materials shall be spread on the hot bitumen at a rate of 400 pounds per square for gravel or 300 pounds per square for other approved surfacing aggregate.

3.16 GLAZE COAT

Glaze coating shall be used to waterproof completed sections when more than one day is required to finish the roofing. If there is a probability of rain falling on the felts before the flood coat and aggregate can be applied, a light glaze coat of bitumen, 10 to 15 pounds per square, shall be applied over the exposed felts. The surfacing operation shall be completed within 48 hours after application of the glaze coat. Where glaze coat is used, surface treatment shall be completed as soon as weather conditions permit.

3.17 ROOF CUT-OUT TESTS

Roof cut-out samples shall be taken and analyzed in accordance with ASTM D 3617 as directed by the Contracting Officer when there is reason to believe that deficiencies exist in the roofing membrane. When samples indicate deficiencies in the built-up roofing, corrective action shall be taken as directed.

3.18 INSPECTION

The Contractor shall establish and maintain an inspection procedure to assure compliance of the installed roofing with the contract requirements. Any work found not to be in compliance with the contract shall be promptly removed and replaced or corrected in an approved manner. Inspection shall include, but not be limited to, the following:

- a. Environmental conditions; number and skill level of roofing workers; start and end time of various tasks; condition of substrate.
- b. Verification of compliance of materials before, during, and after installation.
- c. Inspection of condition of equipment and accuracy of thermometers and metering devices.
- d. Inspection of flashings, cants and curbs.
- e. Inspection of membrane placement, including edge envelopes, widths of starter sheets, laps, proper use of squeegee, and mechanical fastening.
- f. Inspection of application of bitumen, aggregate, and walkways.

- g. Inspection of embedment of aggregate for required weight and coverage.
- h. Cutout sampling and analysis as directed.

3.19 INFRARED INSPECTION

Eight months after completion of the roofing system, the roof surface shall be inspected using infrared (IR) imaging as specified in ASTM C 1153. Where the IR inspection indicates wet insulation, sample cuts shall be taken (including a sample from a suspected dry area) and the moisture content of insulation shall be determined. Insulation shall be replaced where moisture content exceeds the following values: wood fiber: 30 percent, glass fiber: 25 percent, perlite board: 25 percent, and polyurethane: 60 percent. Wet insulation, overlying roofing and sample-cut areas shall be replaced as directed.

End of Section

DIVISION 7 - THERMAL AND MOISTURE PROTECTION

SECTION 07600

SHEET METALWORK, GENERAL

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SECTION 07600

SHEET METALWORK, GENERAL

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 167	(1996) Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM B 32	(1996) Solder Metal
ASTM B 209	(1996) Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B 221	(1996) Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes
ASTM B 370	(1992)e1 Copper Sheet and Strip for Building Construction
ASTM D 226	(1997a) Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing
ASTM D 543	(1995) Resistance of Plastics to Chemical Reagents
ASTM D 822	(1996) Conducting Tests on Paint and Related Coatings and Materials Using Filtered Open-Flame Carbon-Arc Light and Water Exposure Apparatus
ASTM D 828	(1993) Tensile Breaking Strength of Paper and Paperboard
ASTM D 1784	(1997) Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D 2822	(1997)e1 Asphalt Roof Cement
ASTM D 4022	(1994) Coal Tar Roof Cement, Asbestos Containing
ASTM D 4586	(1993) Asphalt Roof Cement, Asbestos Free
ASTM E 96	(1995) Water Vapor Transmission of Materials

SHEET METAL AND AIR CONDITIONING CONTRACTORS NATIONAL ASSOCIATION
(SMACNA)

SMACNA-02

(1993) Architectural Sheet Metal Manual

1.2 GENERAL REQUIREMENTS

Sheet metalwork shall be accomplished to form weathertight construction without waves, warps, buckles, fastening stresses or distortion, and shall allow for expansion and contraction.

1.2.1 Coordination

Cutting, fitting, drilling, and other operations in connection with sheet metal required to accommodate the work of other trades shall be performed by sheet metal mechanics. Application of bituminous strip flashing over various sheet metal items is covered in Section 07510 BUILT-UP ROOFING. Installation of sheet metal items used in conjunction with roofing shall be coordinated with roofing work to permit continuous roofing operations. Sheet metalwork pertaining to heating, ventilating, and air conditioning is specified in Division 15.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-04 Drawings

Materials; FIO.

Drawings of sheet metal items showing weights, gauges or thicknesses; types of materials; expansion-joint spacing; fabrication details; and installation procedures.

1.4 DELIVERY, STORAGE, AND HANDLING

Materials shall be adequately packaged and protected during shipment and shall be inspected for damage, dampness, and wet-storage stains upon delivery to the jobsite. Materials shall be clearly labeled as to type and manufacturer. Sheet metal items shall be carefully handled to avoid damage. Materials shall be stored in dry, ventilated areas until immediately before installation.

PART 2 PRODUCTS

2.1 MATERIALS

Lead, lead-coated metal, and galvanized steel shall not be used. Any metal listed by SMACNA-02 for a particular item may be used, unless otherwise specified or indicated. Materials shall conform to the requirements specified below and to the thicknesses and configurations established in SMACNA-02. Different items need not be of the same metal, except that if copper is selected for any exposed item, all exposed items shall be copper.

2.1.1 Accessories

Accessories and other items essential to complete the sheet metal installation, though not specifically indicated or specified, shall be provided.

2.1.2 Aluminum Extrusions

ASTM B 221, Alloy 6063, Temper T5.

2.1.3 Bituminous Cement

Type I asphalt cement conforming to ASTM D 2822 or ASTM D 4586. For coal tar roofing; coal tar cement conforming to ASTM D 4022.

2.1.4 Sealant

Unless otherwise specified, sealant shall be an elastomeric weather resistant sealant as specified in Section 07900 JOINT SEALING.

2.1.5 Fasteners

Fasteners shall be compatible with the fastened material and shall be the type best suited for the application.

2.1.6 Felt

ASTM D 226, Type I.

2.1.7 Polyvinyl Chloride (PVC) Reglets

ASTM D 1784, Class 14333D, 0.075 inch minimum thickness.

2.1.8 Aluminum Alloy Sheet and Plate

ASTM B 209, anodized clear form, alloy, and temper appropriate for use.

2.1.9 Copper

ASTM B 370, Temper H 00.

2.1.10 Stainless Steel

ASTM A 167, Type 302 or 304; fully annealed, dead soft temper.

2.1.11 Solder

ASTM B 32, 95-5 tin-antimony.

2.1.12 Through-Wall Flashing

Through-wall flashing may be any of the following materials:

- a. Electro-sheet copper not less than 5 ounces, factory coated both sides with acid- and alkali-resistant bituminous compound not less than 6 ounces per square foot or factory covered both sides with asphalt-saturated cotton fabric, asphalt saturated glass-fiber fabric, or with 40 pound reinforced kraft paper bonded with asphalt.
- b. Stainless steel, Type 304, not less than 0.003 inch thick, completely encased by and permanently bonded on both sides to 50 pound high strength bituminized crepe kraft paper, using hot asphalt, heat, and pressure.
- c. Nonreinforced, waterproof, impermeable extruded elastomeric single ply sheeting not less than 30 mils thick.
- d. Three ounce copper sheet, with 2 mils of dense, clear, polyethylene sheet bonded to each side of the copper.
- e. Other through-wall flashing material may be used provided the following performance criteria are met.
 - (1) No cracking or flaking when bent 180 degrees over a 1/32 inch mandrel and rebent at the same point over the same mandrel in an opposite direction at 32 degrees F.
 - (2) Water vapor permeability not more than 2 perms when tested in accordance with ASTM E 96.
 - (3) Minimum breaking strength of 90 pounds per inch width in the weakest direction when tested in accordance with ASTM D 828.
 - (4) No visible deterioration after being subjected to a 400-hour direct weathering test in accordance with ASTM D 822.
 - (5) No shrinkage in length or width and less than 5 percent loss of breaking strength after a 10-day immersion, per ASTM D 543, in 5 percent (by weight) solutions, respectively, of sulfuric acid, hydrochloric acid, sodium hydroxide or saturated lime (calcium hydroxide).

PART 3 EXECUTION

3.1 GENERAL

Items such as gutters, downspouts and louvers shall be fabricated in conformance with SMACNA-02 and as indicated. Unless otherwise specified or indicated, exposed edges shall be folded back to form a 1/2 inch hem on the concealed side, and bottom edges of exposed vertical surfaces shall be angled to form drips. Bituminous cement shall not be placed in contact with roofing membranes other than built-up roofing.

3.2 EXPANSION JOINTS

Expansion joints shall be provided as specified in SMACNA-02. Expansion joints in continuous sheet metal shall be provided at 40 foot intervals for copper and stainless steel and at 32 foot intervals for aluminum, except extruded aluminum gravel stops and fasciae which shall have expansion joints at not more than 12 foot spacing. Joints shall be evenly spaced. An additional joint shall be provided where the distance between the last expansion joint and the end of the continuous run is more than half the required interval spacing.

3.3 PROTECTION OF ALUMINUM

Aluminum shall not be used where it will be in contact with copper or where it will contact water which flows over copper surfaces. Aluminum that will be in contact with wet or pressure-treated wood, mortar, concrete, masonry, or ferrous metals shall be protected against galvanic or corrosive action by one of the following methods:

3.3.1 Paint

Aluminum surfaces shall be solvent cleaned and given one coat of zinc-molybdate primer and one coat of aluminum paint as specified in Section 09900 PAINTING, GENERAL.

3.3.2 Nonabsorptive Tape or Gasket

Nonabsorptive tape or gasket shall be placed between the adjoining surfaces and cemented to the aluminum surface using a cement compatible with aluminum.

3.4 CONNECTIONS AND JOINTING

3.4.1 Soldering

Soldering shall apply to copper and stainless steel items. Edges of sheet metal shall be pretinned before soldering is begun. Soldering shall be done slowly with well heated soldering irons so as to thoroughly heat the seams and completely sweat the solder through the full width of the seam. Edges of stainless steel to be pretinned shall be treated with soldering acid flux. Soldering shall follow immediately after application of the flux. Upon completion of soldering, the acid flux residue shall be thoroughly cleaned from the sheet metal with a water solution of washing soda and rinsed with clean water.

3.4.2 Riveting

Joints in aluminum sheets 0.040 inch or less in thickness shall be mechanically made.

3.4.3 Seaming

Flat-lock and soldered-lap seams shall finish not less than 1 inch wide. Unsoldered plain-lap seams shall lap not less than 3 inches unless otherwise specified. Flat seams shall be made in the direction of the flow.

3.5 CLEATS

A continuous cleat shall be provided where indicated or specified to secure loose edges of the sheet metalwork. Butt joints of cleats shall be spaced approximately 1/8 inch apart. The cleat shall be fastened to supporting wood construction with nails evenly spaced not over 12 inches on centers. Where the fastening is to be made to concrete or masonry, screws shall be used and shall be driven in expansion shields set in concrete or masonry.

3.6 CONDUCTOR HEAD AND DOWNSPOUTS

Conductor heads and downspouts shall be installed as indicated. Downspouts shall be rigidly attached to the building. Supports for downspouts shall be spaced according to manufacturer's recommendations.

3.7 FLASHINGS

Flashings shall be installed at locations indicated and as specified below. Sealing shall be according to the flashing manufacturer's recommendations. Flashings shall be installed at intersections of roof with vertical surfaces and at projections through roof, except that flashing for heating and plumbing, including piping, roof, and floor drains, and for electrical conduit projections through roof or walls are specified in other sections. Except as otherwise indicated, counter flashings shall be provided over base flashings. Perforations in flashings made by masonry anchors shall be covered up by an application of bituminous plastic cement at the perforation. Flashing shall be installed on top of joint reinforcement. Flashing shall be formed to direct water to the outside of the system.

3.7.1 Base Flashing

Metal base flashing shall be coordinated with roofing work. Metal base flashing shall be set in plastic bituminous cement over the roofing membrane, nailed to nailing strip, and secured in place on the roof side with nails spaced not more than 3 inches on centers. Metal base flashing shall not be used on built-up roofing.

3.7.2 Counter Flashings

Except as otherwise indicated, counter flashings shall be provided over base flashings. Counter flashing shall be installed as shown on the drawings. Where bituminous base flashings are provided, the counter flashing shall extend down as close as practicable to the top of the cant strip. Counter flashing shall be factory formed to provide spring action against the base flashing.

3.7.3 Through-Wall Flashing

Through-wall flashing includes sill, lintel, and spandrel flashing. The flashing shall be laid with a layer of mortar above and below the flashing so that the total thickness of the two layers of the mortar and flashing are the same thickness as the regular mortar joints. Flashing shall not extend further into the masonry backup wall than the first mortar joint. Joints in flashing shall be lapped and sealed. Flashing shall be one piece for lintels and sills.

3.7.3.1 Lintel Flashing

Lintel flashing shall extend the full length of lintel. Flashing shall extend through the wall one masonry course above the lintels and shall be bent down over the vertical leg of the outer steel lintel

angle not less than 2 inches, or shall be applied over top of masonry and precast concrete lintels. Bedjoints of lintels at control joints shall be underlaid with sheet metal bond breaker.

3.7.3.2 Sill Flashing

Sill flashing shall extend the full width of the sill and not less than 4 inches beyond ends of sill except at control joint where the flashing shall be terminated at the end of the sill.

3.8 REGLETS

Reglets shall be a factory fabricated product of proven design, complete with fittings and special shapes as required. Open-type reglets shall be filled with fiberboard or other suitable separator to prevent crushing of the slot during installation. Reglet plugs shall be spaced not over 12 inches on centers and reglet grooves shall be filled with sealant. Friction or slot-type reglets shall have metal flashings inserted the full depth of slot and shall be lightly punched every 12 inches to crimp the reglet and counter flashing together. Polyvinyl chloride reglets shall be sealed with the manufacturer's recommended sealant.

3.9 CONTRACTOR QUALITY CONTROL

The Contractor shall establish and maintain a quality control procedure for sheet metal used in conjunction with roofing to assure compliance of the installed sheet metalwork with the contract requirements. Any work found not to be in compliance with the contract shall be promptly removed and replaced or corrected in an approved manner. Quality control shall include, but not be limited to, the following:

- a. Observation of environmental conditions; number and skill level of sheet metal workers; condition of substrate.
- b. Verification of compliance of materials before, during, and after installation.
- c. Inspection of sheet metalwork for proper size and thickness, fastening and joining, and proper installation.

The actual quality control observations and inspections shall be documented and a copy of the documentation furnished to the Contracting Officer at the end of each day.

End of Section

DIVISION 7 - THERMAL AND MOISTURE PROTECTION

SECTION 07900

JOINT SEALING

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SECTION 07900

JOINT SEALING

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 570	(1995) Oil- and Resin-Base Caulking Compound for Building Construction
ASTM C 834	(1995) Latex Sealants
ASTM C 920	(1998) Elastomeric Joint Sealants
ASTM C 1184	(1995)e1 Structural Silicone-Sealants
ASTM D 1056	(1991) Flexible Cellular Materials - Sponge or Expanded Rubber
ASTM D 1565	81(1990) Flexible Cellular Materials - Vinyl Chloride Polymers and Copolymers (Open-Cell Foam)

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Backing; GA. Bond-Breaker; GA.
Sealant; GA.

Manufacturer's descriptive data including storage requirements, shelf life, curing time, instructions for mixing and application, and primer data (if required). A copy of the Material Safety Data Sheet shall be provided for each solvent, primer or sealant material.

SD-13 Certificates

Sealant; GA.

Certificates of compliance stating that the materials conform to the specified requirements.

1.3 ENVIRONMENTAL REQUIREMENTS

The ambient temperature shall be within the limits of 40 to 90 degrees F when the sealants are applied.

1.4 DELIVERY AND STORAGE

Materials shall be delivered to the job in the manufacturer's original unopened containers. The container label or accompanying data sheet shall include the following information as applicable: manufacturer, name of material, formula or specification number, lot number, color, date of manufacture, mixing instructions, shelf life, and curing time at the standard conditions for laboratory tests. Materials shall be handled and stored to prevent inclusion of foreign materials. Materials shall be stored at temperatures between 40 and 90 degrees F unless otherwise specified by the manufacturer.

PART 2 PRODUCTS

2.1 BACKING

Backing shall be 25 to 33 percent oversize for closed cell and 40 to 50 percent oversize for open cell material, unless otherwise indicated.

2.1.1 Rubber

Cellular rubber sponge backing shall be ASTM D 1056, Type 2, closed cell, Class A B, Grade 1, round cross section.

2.1.2 PVC

Polyvinyl chloride (PVC) backing shall be ASTM D 1565, Grade VO 12, open-cell foam, round cross section.

2.1.3 Neoprene

Neoprene backing shall be ASTM D 1056, closed cell expanded neoprene cord Type 2, Class C, Grade 2C2.

2.2 BOND-BREAKER

Bond-breaker shall be as recommended by the sealant manufacturer to prevent adhesion of the sealant to backing or to bottom of the joint.

2.3 PRIMER

Primer shall be non-staining type as recommended by sealant manufacturer for the application.

2.4 CAULKING

Oil- and resin-based caulking shall be ASTM C 570, Type I, Use interior.

2.5 SEALANT

2.5.1 Latex

Latex Sealant shall be ASTM C 834.

2.5.2 Elastomeric

Elastomeric sealants shall conform to ASTM C 920 and the following:

- a. Polysulfide Sealant: Type S, Grade NS, Class 25, Use NT, M.
- b. Polyurethane sealant: Grade NS, Class 25, Use NT.
- c. Silicone sealant: Type S, Grade NS, Class 25, Use NT, M.
- d. Structural silicone sealant: ASTM C 1184, Type S, Use G and O.

2.6 SOLVENTS AND CLEANING AGENTS

Solvents, cleaning agents, and accessory materials shall be provided as recommended by the manufacturer.

PART 3 EXECUTION

3.1 GENERAL

3.1.1 Surface Preparation

The surfaces of joints to receive sealant or caulk shall be free of all frost, condensation and moisture. Oil, grease, dirt, chalk, particles of mortar, dust, loose rust, loose mill scale, and other foreign substances shall be removed from surfaces of joints to be in contact with the sealant. Oil and grease shall be removed with solvent and surfaces shall be wiped dry with clean cloths. For surface types not listed below, the sealant manufacturer shall be contacted for specific recommendations.

3.1.2 Concrete and Masonry Surfaces

Where surfaces have been treated with curing compounds, oil, or other such materials, the materials shall be removed by sandblasting or wire brushing. Laitance, efflorescence and loose mortar shall be removed from the joint cavity.

3.1.3 Steel Surfaces

Steel surfaces to be in contact with sealant shall be sandblasted or, if sandblasting would not be practical or would damage adjacent finish work, the metal shall be scraped and wire brushed to remove loose mill scale. Protective coatings on steel surfaces shall be removed by sandblasting or by a solvent that leaves no residue.

3.1.4 Aluminum Surfaces

Aluminum surfaces to be in contact with sealants shall be cleaned of temporary protective coatings. When masking tape is used for a protective cover, the tape and any residual adhesive shall be removed just prior to applying the sealant. Solvents used to remove protective coating shall be as recommended by the manufacturer of the aluminum work and shall be non-staining.

3.1.5 Wood Surfaces

Wood surfaces to be in contact with sealants shall be free of splinters and sawdust or other loose particles.

3.2 APPLICATION

3.2.1 Masking Tape

Masking tape may be placed on the finish surface on one or both sides of a joint cavity to protect adjacent finish surfaces from primer or sealant smears. Masking tape shall be removed within 10 minutes after joint has been filled and tooled.

3.2.2 Backing

Backing shall be installed to provide the indicated sealant depth. The installation tool shall be shaped to avoid puncturing the backing.

3.2.3 Bond-Breaker

Bond-breaker shall be applied to fully cover the bottom of the joint without contaminating the sides where sealant adhesion is required.

3.2.4 Primer

Primer shall be used on concrete masonry units, wood, or other porous surfaces in accordance with instructions furnished with the sealant. Primer shall be applied to the joint surfaces to be sealed. Surfaces adjacent to joints shall not be primed.

3.2.5 Sealant

Sealant shall be used before expiration of shelf life. Multi-component sealants shall be mixed according to manufacturer's printed instructions. Sealant in guns shall be applied with a nozzle of proper size to fit the width of joint. Joints shall be sealed as detailed in the drawings. Sealant shall be forced into joints with sufficient pressure to expel air and fill the groove solidly. Sealant shall be installed to the indicated depth without displacing the backing. Unless otherwise indicated, specified, or recommended by the manufacturer, the installed sealant shall be dry tooled to produce a uniformly smooth surface free of wrinkles and to ensure full adhesion to the sides of the joint; the use of solvents, soapy water, etc., will not be allowed. Sealants shall be installed free of air pockets, foreign embedded matter, ridges and sags. Sealer shall be applied over the sealant when and as specified by the sealant manufacturer.

3.3 CLEANING

The surfaces adjoining the sealed joints shall be cleaned of smears and other soiling resulting from the sealant application as work progresses.

End of Section

DIVISION 8 - DOORS AND WINDOWS

SECTION 08110

STEEL DOORS AND FRAMES

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SECTION 08110

STEEL DOORS AND FRAMES

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 236	89(1993)e1 Steady-State Thermal Performance of Building Assemblies by Means of a Guarded Hot Box
ASTM C 976	90(1996)e1 Thermal Performance of Building Assemblies by Means of a Calibrated Hot Box
ASTM D 2863	(1997) Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index)
ASTM E 283	(1991) Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen

DOOR AND HARDWARE INSTITUTE (DHI)

DHI A115.1G	(1994) Installation Guide for Doors and Hardware
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STEEL DOOR INSTITUTE (SDOI)

SDOI SDI-100	(1991) Standard Steel Doors and Frames
SDOI SDI-106	(1996) Standard Door Type Nomenclature
SDOI SDI-107	(1984) Hardware on Steel Doors (Reinforcement - Application)

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-04 Drawings

Steel Doors and Frames; GA.

Drawings using standard door type nomenclature in accordance with SDOI SDI-106 indicating the location of each door and frame, elevation of each model of door and frame, details of construction, method of assembling sections, location and extent of hardware reinforcement, hardware locations, type and location of anchors for frames, and thicknesses of metal. Drawings shall include catalog cuts or descriptive data for the doors, frames, and weatherstripping including air infiltration data and manufacturer's printed instructions.

SD-13 Certificates

Thermal Insulated Doors; GA.

- a. Certification of Thermal Insulating Rating: Certification or test report for thermal insulated doors shall show compliance with the specified requirements. The certification, or test report, shall list the parameters and the type of hardware and perimeter seals used to achieve the rating.

1.3 DELIVERY AND STORAGE

During shipment, welded unit type frames shall be strapped together in pairs with heads at opposite ends or shall be provided with temporary steel spreaders at the bottom of each frame; and knockdown type frames shall be securely strapped in bundles. Materials shall be delivered to the site in undamaged condition, and stored out of contact with the ground and under a weathertight covering permitting air circulation. Doors and assembled frames shall be stored in an upright position in accordance with DHI A115.1G. Abraded, scarred, or rusty areas shall be cleaned and touched up with matching finishes.

1.4 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a 1 year period shall be provided.

PART 2 PRODUCTS

2.1 DOORS AND FRAMES

Doors and frames shall be factory fabricated in accordance with SDOI SDI-100 and the additional requirements specified herein. Door grade shall be heavy duty (Grade II) unless otherwise indicated on the door and door frame schedules. Doors and frames shall be prepared to receive hardware conforming to the templates and information provided under Section 08700 BUILDERS' HARDWARE. Doors and frames shall be reinforced, drilled, and tapped to receive mortised hinges, locks, latches, and flush bolts as required. Doors and frames shall be reinforced for surface applied hardware. Frames shall be welded type located as shown. Door frames shall be furnished with a minimum of three jamb anchors and one floor anchor per jamb. Anchors shall be not less than 18 gauge steel or 7 gauge diameter wire. For wall conditions that do not allow the use of a floor anchor, an additional jamb anchor shall be provided. Rubber silencers shall be furnished for installation into factory predrilled holes in door frames; adhesively applied silencers are not acceptable. Where frames are installed in plaster or masonry walls, plaster guards shall be provided on door frames at hinges and strikes. Reinforcing of door assemblies for closers and other required hardware shall be in accordance with SDOI SDI-100. Exterior doors shall have top edges closed flush and sealed against water penetration.

2.2 THERMAL INSULATED DOORS

The interior of thermal insulated doors shall be completely filled with rigid plastic foam permanently bonded to each face panel. The thermal conductance (U-value) through the door shall not exceed 0.41 btu/hr times sq f times f when tested as an operational assembly in accordance with ASTM C 236 or ASTM C 976. Doors with cellular plastic cores shall have a minimum oxygen index rating of 22 percent when tested in accordance with ASTM D 2863.

2.3 WEATHERSTRIPPING

Unless otherwise specified in Section 08700 BUILDERS' HARDWARE, weatherstripping shall be as follows: Weatherstripping for head and jamb shall be manufacturer's standard elastomeric type of synthetic rubber, vinyl, or neoprene and shall be installed at the factory or on the jobsite in accordance with the door frame manufacturer's recommendations. Weatherstripping for bottom of doors shall be as shown. Air leakage rate of weatherstripping shall not exceed 0.20 cfm per linear foot of crack when tested in accordance with ASTM E 283 at standard test conditions.

2.4 LOUVERS

Where indicated, doors shall be provided with louver sections. Louvers shall be sightproof type inserted into the door. Inserted louvers shall be stationary. Louvers shall be nonremovable from the outside of exterior doors or the unsecured side of interior doors.

2.5 FACTORY FINISH

Doors and frames shall be phosphatized and primed with standard factory primer system. Color shall be grey.

PART 3 EXECUTION

3.1 INSTALLATION

Installation shall be in accordance with DHI A115.1G. Preparation for surface applied hardware shall be in accordance with SDOI SDI-107. Rubber silencers shall be installed in door frames after finish painting has been completed; adhesively applied silencers are not acceptable. Weatherstripping shall be installed at exterior door openings to provide a weathertight installation. Hollow metal door frames shall be solid grouted in masonry walls.

3.1.1 Thermal Insulated Doors

Hardware and perimeter seals shall be adjusted for proper operation. Doors shall be sealed weathertight after installation of hardware and shall be in accordance with Section 07900 JOINT SEALING.

3.2 FIELD PAINTED FINISH

Steel doors and frames shall be field painted in accordance with Section 09900 PAINTING, GENERAL. Weatherstrips shall be protected from paint. Finish shall be free of scratches or other blemishes. Color to be selected by Contracting Officer.

End of Section

DIVISION 8 - DOORS AND WINDOWS

SECTION 08330

OVERHEAD ROLLING DOORS

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SECTION 08330

OVERHEAD ROLLING DOORS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 653 (1997) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip process

ASTM E 84 (1998) Surface Burning Characteristics of Building Materials

AMERICAN SOCIETY OF HEATING, REFRIGERATING, AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE-03 (1993) Handbook, Fundamentals I-P Edition

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 2 (1993) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated Not More Than 2,000 Volts AC or 750 Volts DC

NEMA ICS 6 (1993) Industrial Control and Systems Enclosures

NEMA MG 1 (1993; Rev 1, Rev 2, Rev 3) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (1999) National Electrical Code

1.2 DESCRIPTION

Overhead rolling doors shall be spring counterbalanced, rolling type, with interlocking slats, complete with guides, fastenings, hood, brackets, and operating mechanisms, and shall be designed for use on openings as indicated.

1.2.1 Wind Load Requirements

Doors and components shall be designed to withstand the minimum design wind load of 20 psf. Doors shall be constructed to sustain a superimposed load, both inward and outward, equal to 1-1/2 times the minimum design wind load. The door shall support the superimposed loads for a minimum period of

10 seconds without evidence of serious damage and shall be operable after conclusion of the tests. Test data showing compliance with design windload requirements for the door design tested in accordance with a uniform static load equal to 1-1/2 times the minimum design windload, shall be provided. The uniform static load test specimen shall be supported using guides, endlocks, and windlocks as required for project installation. Recovery shall be at least 3/4 of the maximum deflection within 24 hours after the test load is removed.

1.2.2 Operational Cycle Life

All portions of the door and door operating mechanism that are subject to movement, wear, or stress fatigue shall be designed to operate through a minimum number of 10 cycles per day. One complete cycle of door operation is defined as when the door is in the closed position, moves to the full open position, and returns to the closed position.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Overhead Rolling Door Unit; GA.

Manufacturer's catalog data, test data, and summary of forces and loads on the walls/jambs.

SD-04 Drawings

Overhead Rolling Door Unit; GA.

Drawings showing the location of each door including schedules. Drawings shall include elevations of each door type, details and method of anchorage, details of construction, location and installation of hardware, shape and thickness of materials, details of joints and connections, and details of guides, power operators, controls, and other fittings.

SD-06 Instructions

Overhead Rolling Door Unit; FIO.

Manufacturer's preprinted installation instructions.

SD-19 Operation and Maintenance Manuals

Operation Manual; GA.

Maintenance and Repair Manual ; GA.

Six copies of the system operation manual and system maintenance and repair manual for each type of door and control system.

1.4 DELIVERY AND STORAGE

Doors shall be delivered to the jobsite wrapped in a protective covering with the brands and names clearly marked thereon. Doors shall be stored in a dry location that is adequately ventilated and free from dirt and dust, water, and other contaminants, and in a manner that permits easy access for inspection and handling.

1.5 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a 1-year period shall be provided.

1.6 OPERATION AND MAINTENANCE MANUALS

Operating instructions outlining the step-by-step procedures required for motorized door and shutter operation for the overhead rolling door unit shall be provided. The instructions shall include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. Maintenance instructions listing routine maintenance procedures, possible breakdowns and repairs, troubleshooting guides, and simplified diagrams for the equipment as installed shall be provided. A complete list of parts and supplies, source of supply, and a list of the high mortality maintenance parts shall be provided.

PART 2 PRODUCTS

2.1 OVERHEAD ROLLING DOORS

Doors shall be surface-mounted type with guides at jambs set back a sufficient distance to clear the opening. Exterior doors shall be mounted on interior side of walls.

2.1.1 Curtains

The curtains shall roll up on a barrel supported at the head of opening on brackets, and shall be balanced by helical torsion springs. Steel slats for doors less than 15 feet wide shall be minimum bare metal thickness of 0.0269 inches. Slats shall be of the minimum bare metal decimal thickness required for the width indicated and the wind pressure specified above.

2.1.1.1 Non-Insulated Curtains

Curtains shall be formed of interlocking slats of shapes standard with the manufacturer. Slats for exterior doors shall be flat type.

2.1.1.2 Insulated Curtains

The slat system shall supply a minimum R-value of 4 when calculated in accordance with ASHRAE-03. Slats shall be of the flat type as standard with the manufacturer. Slats shall consist of a polystyrene core not less than 11/16 inch thick, completely enclosed within metal facings. Exterior face of slats shall be gauge as specified for curtains. Interior face shall be not lighter than 0.0209 inches. The insulated slat assembly shall have a flame spread rating of not more than 25 and a smoke development factor of not more than 50 when tested in accordance with ASTM E 84.

2.1.2 Endlocks and Windlocks

The ends of each alternate slat for interior doors shall have steel endlocks of manufacturer's stock design. In addition to endlocks, non-rated exterior doors shall have the manufacturer's standard windlocks as required to withstand the wind load. Windlocks shall prevent the curtain from leaving guides because of deflection from specified wind pressure.

2.1.3 Bottom Bar

The curtain shall have a standard bottom bar consisting of two hot-dip galvanized steel angles for steel doors. A sensing edge shall be attached to the bottom bar of doors that are electric-power operated.

2.1.4 Guides

Guides shall be steel structural shapes or formed steel shapes, of a size and depth to provide proper clearance for operation and resistance under the design windload. Guides shall be attached to adjoining construction with fasteners recommended by the manufacturer. Spacing of fasteners shall be as required to meet the minimum design windload. Doors and guides in hazardous areas shall have static grounding.

2.1.5 Barrel

The barrel shall be steel pipe or commercial welded steel tubing of proper diameter for the size of curtain. Deflection shall not exceed 0.03 inch per foot of span. Ends of the barrel shall be closed with metal plugs, machined to fit the pipe. Aluminum plugs are acceptable on non-fire door barrels.

2.1.6 Springs

Oil tempered helical steel counter-balance torsion springs shall be installed within the barrel and shall be capable of producing sufficient torque to assure easy operation of the door curtain. Access shall be provided for spring tension adjustment from outside of the bracket without removing the hood.

2.1.7 Brackets

Brackets shall be of steel plates to close the ends of the roller-shaft housing, and to provide mounting surfaces for the hood. An operation bracket hub and shaft plugs shall have sealed prelubricated ball bearings.

2.1.8 Hoods

Hoods shall be steel with minimum bare metal thickness of 0.0209 inches formed to fit contour of the end brackets, and shall be reinforced with steel rods, rolled beads, or flanges at top and bottom edges. Multiple segment and single piece hoods shall be provided with support brackets of the manufacturer's standard design as required for adequate support.

2.1.9 Weatherstripping

Exterior doors shall be fully weatherstripped. A compressible and replaceable weather seal shall be attached to the bottom bar. Weather seal at door guides shall be continuous vinyl or neoprene, bulb or leaf type, or shall be nylon-brush type. A weather baffle shall be provided at the lintel or inside the hood. Weatherstripping shall be easily replaced without special tools.

2.1.10 Operation

Doors shall be operated by means of electric power with auxiliary chain hoist. Equipment shall be designed and manufactured for usage in non-hazardous areas.

2.1.10.1 Electric Power Operator With Auxiliary Chain Hoist Operation

Electric power operators shall be heavy-duty industrial type. The unit shall operate the door through the operational cycle life specified. The electric power operator shall be complete with electric motor, auxiliary operation, necessary means of reduction, brake, mounting brackets, push button controls, limit switches, magnetic reversing starter, and all other accessories necessary to operate components specified in other paragraphs of this section. The operator shall be so designed that the motor may be removed without disturbing the limit-switches settings and without affecting the emergency chain operator. Doors shall be provided with an auxiliary operator for immediate emergency manual operation of the door in case of electrical failure. Auxiliary operation shall be by means of galvanized endless chain extending to within 3 feet of the floor. The emergency manual operating mechanism shall be so arranged that it may be operated from the floor without affecting the settings of the limit switches. A mechanical device shall be included that will disconnect the motor from the drive operating mechanism when the auxiliary operator is used. Where control voltages differ from motor voltage, a control voltage transformer shall be provided in and as part of the electric power operator system. Control voltage shall not exceed 120 volts.

- a. Motors: Drive motors shall conform to NEMA MG 1, shall be high-starting torque, reversible type, and shall be of sufficient horsepower and torque output to move the door in either direction from any position at a speed range of 6 to 8 inches per second without exceeding the rated capacity. Motors shall be suitable for operation on 208 volts, 60 hertz, 3-phase current and shall be suitable for across-the-line starting. Motors shall be designed to operate at full capacity over a supply voltage variation of plus or minus 10 percent of the motor voltage rating. Motors shall be provided with overload protection.
- b. Controls: Control equipment shall conform to NEMA ICS 2. Enclosures shall conform to NEMA ICS 6, Type 12 (industrial use), Type 7 or 9 in hazardous locations, in accordance with NFPA 70. Exterior control stations shall be weatherproof key-operated type with corrosion-resistant cast-metal cover. Each control station shall be of the three position button type, marked "OPEN," "CLOSE," and "STOP." The "OPEN" and "STOP" controls shall be of the momentary contact type with seal-in contact. The "CLOSE" control shall be of the constant pressure type. When the door is in motion and the "STOP" control is pressed, the door shall stop instantly and remain in the stop position; from the stop position, the door shall be operable in either direction by the "OPEN" or "CLOSE" controls. Controls shall be of the full-guarded type to prevent accidental operation. Readily adjustable limit switches shall be provided to automatically stop the doors at their fully open and closed positions.
- c. Sensing Edge Device: The bottom edge of electric power operated doors shall have an electric sensing edge that will reverse the door movement upon contact with an obstruction and cause the door to return to its full open position. The sensing edge shall not substitute for a limit switch. Exterior doors shall be provided with a combination compressible weather seal and sensing edge.

- d. Electrical Work: Conduit and wiring necessary for proper operation shall be provided under Section 16415 ELECTRICAL WORK, INTERIOR. Flexible connections between doors and fixed supports shall be made with flexible type SJO cable, except in hazardous locations where wiring shall conform to NFPA 70, as appropriate. The cable shall have a spring-loaded automatic take up reel or a coil cord equivalent device.

2.1.11 Inertia Brake

Overhead rolling door shall have a mechanical inertia brake device which will stop the door from free fall in any position, should there be a failure in the motor operator brake or roller chain drive. The unit shall be capable of being reset with a back drive action.

2.1.12 Locking

Locking for motor operated doors shall consist of self-locking gearing and optional master keyed cylinder with electrical interlock with chain lock for emergency hand chain.

2.1.13 Finish

Steel slats and hoods shall be hot-dip galvanized G90 in accordance with ASTM A 653 and shall be treated for paint adhesion and shall receive a factory baked-on prime coat for field finishing. The paint system shall withstand a minimum of 1500 hours without blistering, bubbling, or rust. Surfaces other than slats, hood, and faying surfaces shall be cleaned and treated to assure maximum paint adherence and shall be given a factory dip or spray coat of rust inhibitive metallic oxide or synthetic resin primer. Color to be selected by the Contracting Officer.

PART 3 EXECUTION

3.1 INSTALLATION

Doors shall be installed in accordance with approved detail drawings and manufacturer's instructions. Anchors and inserts for guides, brackets, motors, switches, hardware, and other accessories shall be accurately located. Upon completion, doors shall be free from warp, twist, or distortion. Doors shall be lubricated, properly adjusted, and demonstrated to operate freely.

3.2 FIELD PAINTED FINISH

Steel doors and frames shall be field painted in accordance with Section 09900 PAINTING, GENERAL. Weatherstrips shall be protected from paint. Finish shall be free of scratches or other blemishes. Color to be selected by the Contracting Officer.

End of Section

DIVISION 8 - DOORS AND WINDOWS

SECTION 08520

ALUMINUM WINDOWS

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SECTION 08520

ALUMINUM WINDOWS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

ALUMINUM ASSOCIATION (AA)

AA DAF-45 (1980) Designation System for Aluminum Finishes

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA 101 (1993) Voluntary Specifications for Aluminum and Poly (Vinyl Chloride) (PVC) Prime Windows and Glass Doors

AAMA 1503.1 (1988) Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM E 283 (1991) Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen

ASTM E 330 (1990) Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference

ASTM E 547 (1996) Water Penetration of Exterior Windows, Curtain Walls, and Doors by Cyclic Static Air Pressure Differential

1.2 WINDOW PERFORMANCE

Aluminum windows shall be designed to meet the following performance requirements. Testing requirements shall be performed by an independent testing laboratory or agency.

1.2.1 Structural Performance

Structural test pressures on window units shall be for positive load (inward) and negative load (outward) in accordance with ASTM E 330. After testing, there shall be no glass breakage, permanent damage to fasteners, hardware parts, support arms or actuating mechanisms or any other damage which could cause window to be inoperable. There shall be no permanent deformation of any main frame, sash or ventilator member in excess of the requirements established by AAMA 101 for the window types and classification specified in this section.

1.2.2 Air Infiltration

Air infiltration shall not exceed the amount established by AAMA 101 for each window type when tested in accordance with ASTM E 283.

1.2.3 Water Penetration

Water penetration shall not exceed the amount established by AAMA 101 for each window type when tested in accordance with ASTM E 547.

1.2.4 Thermal Performance

Thermal transmittance for thermally broken aluminum windows with insulating glass shall not exceed R-Value Class R2.5 when tested in accordance with AAMA 1503.1.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Aluminum Windows; GA.

Manufacturer's descriptive data and catalog cut sheets.

SD-04 Drawings

Aluminum Windows; GA.

Drawings indicating elevations of window, rough-opening dimensions for each type and size of window, full-size sections, thicknesses of metal, fastenings, methods of installation and anchorage, connections with other work, type of wall construction, size and spacing of anchors, method of glazing, types and locations of operating hardware, mullion details, weatherstripping details, and window schedules showing locations of each window type.

SD-06 Instructions

Aluminum Windows; GA.

Manufacturer's preprinted installation instructions and cleaning instructions.

SD-09 Reports

Aluminum Windows; GA.

Reports for each type of aluminum window attesting that identical windows have been tested and meet all performance requirements established under paragraph WINDOW PERFORMANCE.

SD-13 Certificates

Aluminum Windows; GA.

Certificates stating that the aluminum windows are AAMA certified conforming to requirements of this section. Labels or markings permanently affixed to the window will be accepted in lieu of certificates.

SD-14 Samples

Aluminum Windows; GA.

Manufacturer's standard color samples of the specified finishes.

1.4 QUALIFICATION

Window manufacturer shall specialize in designing and manufacturing the type of aluminum windows specified in this section, and shall have a minimum of 10 years of documented successful experience. Manufacturer shall have the facilities capable of meeting contract requirements, single-source responsibility and warranty.

1.5 DELIVERY AND STORAGE

Aluminum windows shall be delivered to project site and stored in accordance with manufacturer's recommendations. Damaged windows shall be replaced with new windows.

1.6 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a 1 year period shall be provided.

PART 2 PRODUCTS

2.1 ALUMINUM WINDOW TYPES

Aluminum windows shall consist of complete units including sash, glass, frame, weatherstripping, and hardware. Windows shall conform to AAMA 101. Windows shall be double-glazed. Operable windows shall permit cleaning the outside glass from inside the building.

2.1.1 Fixed Windows

Aluminum fixed windows shall conform to AAMA 101 F-C20 architectural grade, non-operable glazed frame, complete with provisions for reglazing in the field.

2.2 GLASS AND GLAZING

Aluminum windows shall be designed for inside glazing, field glazing, and for glass types scheduled on drawings. Units shall be complete with glass and glazing provisions to meet AAMA 101. Glazing material shall be compatible with aluminum, and shall not require painting. Exterior glazing sheet shall be bullet resistant polycarbonate glass. Interior glazing sheet shall be 1/4 inch tempered glass.

2.3 FINISH

Exposed surfaces of aluminum windows shall be finished with anodic coating conforming to AA DAF-45: Architectural Class I, AA-M10-C22-A41, clear anodic coating, 0.7 mil or thicker, 215-R1 Natural Color Class I, AA-M10-C22-A44, color anodic coating, 0.7 mil or thicker. Finish shall be free of scratches and other blemishes.

PART 3 EXECUTION

3.1 INSTALLATION

Aluminum windows shall be installed in accordance with approved shop drawings and manufacturer's published instructions. Aluminum surfaces in contact with masonry, concrete, wood and dissimilar metals other than stainless steel, zinc, cadmium or small areas of white bronze, shall be protected from direct contact using protective materials recommended by AAMA 101. The completed window installation shall be watertight in accordance with Section 07900 JOINT SEALING. Glass and glazing shall be installed in accordance with requirements of this section.

3.2 CLEANING

Aluminum window finish and glass shall be cleaned on exterior and interior sides in accordance with window manufacturer's recommendations. Alkaline or abrasive agents shall not be used. Precautions shall be taken to avoid scratching or marring window finish and glass surfaces.

End of Section

DIVISION 8 - DOORS AND WINDOWS

SECTION 08700

BUILDERS' HARDWARE

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SECTION 08700

BUILDERS' HARDWARE

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM E 283	(1991) Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls and Doors Under Specified Pressure Differences Across the Specimen
ASTM F 883	(1997) Padlocks

BUILDERS HARDWARE MANUFACTURERS ASSOCIATION (BHMA)

BHMA-01	(Effective thru Jun 1995) Directory of Certified Locks & Latches
BHMA-02	(Effective thru Jul 1995) Directory of Certified Door Closers
BHMA-03	(Effective thru Jul 1996) Directory of Certified Exit Devices
BHMA ANSI/BHMA A156.1	(1997) Butts and Hinges
BHMA ANSI/BHMA A156.2	(1996) Bored and Preassembled Locks and Latches
BHMA ANSI/BHMA A156.3	(1994) Exit Devices
BHMA ANSI/BHMA A156.4	(1992) Door Controls - Closers
BHMA ANSI/BHMA A156.5	(1992) Auxiliary Locks & Associated Products
BHMA ANSI/BHMA A156.6	(1994) Architectural Door Trim
BHMA ANSI/BHMA A156.7	(1997) Template Hinge Dimensions
BHMA ANSI/BHMA A156.8	(1994) Door Controls - Overhead Stops and Holders
BHMA ANSI/BHMA A156.13	(1994) Mortise Locks & Latches
BHMA ANSI/BHMA A156.16	(1997) Auxiliary Hardware
BHMA ANSI/BHMA A156.18	(1993) Materials and Finishes

BHMA ANSI/BHMA A156.20 (1989) Strap and Tee Hinges and Hasps

BHMA ANSI/BHMA A156.21 (1989) Thresholds

DOOR AND HARDWARE INSTITUTE (DHI)

DHI-03 (1989) Keying Systems and Nomenclature

DHI-04 (1996) Recommended Locations for Builders' Hardware for Custom Steel Doors and Frames

DHI-05 (1990) Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames

DHI-A115.IG (1994) Installation Guide for Doors and Hardware

DHI A115-W (Varies) Wood Door Hardware Standards (Include all 5-W1 thru A115-W9)

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Hardware and Accessories; GA.

Manufacturer's descriptive data, technical literature, catalog cuts, and installation instructions. Spare parts data for locksets, exit devices, closers, after approval of the detail drawings, and not later than 3 months prior to the date of beneficial occupancy. The data shall include a complete list of parts and supplies, with current unit prices and source of supply.

SD-04 Drawings

Hardware Devices; GA.

Detail drawings for hardware devices for computerized keying systems, magnetic cards, keyless push button access control systems, and other electrical hardware devices showing complete wiring and schematic diagrams and other details required to demonstrate proper function of units.

SD-07 Schedules

Hardware Schedule; GA.

Hardware schedule listing all items to be furnished. The schedule shall include for each item: the quantities; manufacturer's name and catalog numbers; the ANSI number specified, sizes; detail information or catalog cuts; finishes; door and frame size and materials; location and hardware set identification cross-references to drawings; corresponding reference standard type number or function

number from manufacturer's catalog if not covered by ANSI or BHMA; and list of abbreviations and template numbers.

Keying Schedule; GA.

Keying schedule developed in accordance with DHI-03, after the keying meeting with the user.

SD-13 Certificates

Hardware and Accessories; GA.

The hardware manufacturer's certificates of compliance stating that the supplied material or hardware item meets specified requirements. Each certificate shall be signed by an official authorized to certify in behalf of the product manufacturer and shall identify quantity and date or dates of shipment or delivery to which the certificates apply. A statement that the proposed hardware items appear in BHMA-01, BHMA-02 and BHMA-03 directories of certified products may be submitted in lieu of certificates.

1.3 PREDELIVERY CONFERENCE

Upon approval of the Hardware Schedule, the construction Contractor shall arrange a conference with the hardware supplier, Contracting Officer and the using agency to determine keying system requirements. Location of the key control storage system, set-up and key identification labeling will also be determined.

1.4 DELIVERY, STORAGE, AND HANDLING

Hardware shall be delivered to the project site in the manufacturer's original packages. Each article of hardware shall be individually packaged in the manufacturer's standard commercial carton or container, and shall be properly marked or labeled to be readily identifiable with the approved hardware schedule. Each change key shall be tagged or otherwise identified with the door for which its cylinder is intended. Where double cylinder functions are used or where it is not obvious which is the key side of a door, appropriate instructions shall be included with the lock and on the hardware schedule. Manufacturer's printed installation instructions, fasteners, and special tools shall be included in each package.

1.5 SPECIAL TOOLS

Special tools, such as those supplied by the manufacturer, unique wrenches, and dogging keys, shall be provided as required to adjust hardware items.

1.6 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a one year period shall be provided.

1.7 OPERATION AND MAINTENANCE MANUALS

Six complete copies of maintenance instructions listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides shall be provided.

PART 2 PRODUCTS

2.1 GENERAL HARDWARE REQUIREMENTS

Hardware shall conform to the requirements specified herein and the HARDWARE SETS listing at the end of this section. Hardware set numbers correspond to the set numbers shown on the drawings.

2.2 TEMPLATES

Requirements for hardware to be mounted on metal doors or metal frames shall be coordinated between hardware manufacturer and door or frame manufacturer by use of templates and other information to establish location, reinforcement required, size of holes, and similar details. Templates of hinges shall conform to BHMA ANSI/BHMA A156.7.

2.3 HINGES

Hinges shall conform to BHMA ANSI/BHMA A156.1. Hinges used on metal doors and frames shall also conform to BHMA ANSI/BHMA A156.7. Except as otherwise specified, hinge sizes shall conform to the hinge manufacturer's printed recommendations.

2.4 LOCKS AND LATCHES

To the maximum extent possible, locksets, latchsets and deadlocks shall be the products of a single manufacturer.

2.4.1 Mortise Lock and Latchsets

Mortise lock, latchsets, and strikes shall be series 1000 and shall conform to BHMA ANSI/BHMA A156.13, operational Grade 1. Mortise type locks and latches for doors 1-3/4 inches thick and over shall have adjustable bevel fronts or otherwise conform to the shape of the door. Mortise locks shall have armored fronts.

2.4.2 Auxiliary Locks and Associated Products

Bored and mortise dead locks and dead latches, rim latches, dead latches, and dead bolts, shall conform to BHMA ANSI/BHMA A156.5. Bolt and latch retraction shall be dead bolt style. Strike boxes shall be furnished with dead bolt and latch strikes for Grade 1.

2.4.3 Lock Cylinders (Mortise, Rim and Bored)

Lock cylinders shall comply with BHMA ANSI/BHMA A156.5. Lock cylinder shall have not less than six pins. Cylinders shall have key removable type cores. A grand master keying system shall be provided. Construction interchangeable cores shall be provided. Disassembly of knob or lockset shall not be required to remove core from lockset. All locksets, lockable exit devices, and padlocks shall accept same interchangeable cores.

2.4.4 Padlocks

Padlocks shall conform to ASTM F 883. Straps, tee hinges, and hasps shall conform to BHMA ANSI/BHMA A156.20.

2.4.5 Lock Trim

Lock trim shall be cast, forged, or heavy wrought construction of commercial plain design. In addition to meeting the test requirement of BHMA ANSI/BHMA A156.2 or BHMA ANSI/BHMA A156.13, knobs, lever handles, roses, and escutcheons shall be 0.050 inch thick, if unreinforced. If reinforced, the outer shell shall be 0.035 inch thick and the combined thickness shall be 0.070 inch except that knob shanks shall be 0.060 inch thick. Knob diameter shall be 2-1/8 to 2-1/4 inches. Lever handles shall be of plain design with ends returned to no more than 1/2 inch from the door face.

2.5 EXIT DEVICES AND EXIT DEVICE ACCESSORIES

Exit devices and exit device accessories shall conform to BHMA ANSI/BHMA A156.3, Grade 1.

2.5.1 Exit Devices and Auxiliary Items

Trim shall be of wrought construction and commercial plain design with straight, beveled, or smoothly rounded sides, corners, and edges. Adjustable strikes shall be provided for rim type and vertical rod devices. Open back strikes shall be provided for pairs of doors with mortise and vertical rod devices; except open back strikes shall be used on labeled doors only where specifically provided for in the published listings. Escutcheons shall be provided not less than 7 by 2-1/4 inches. Escutcheons shall be cut to suit cylinders and operating trim.

2.6 KEYING

Locks shall be keyed in sets or subsets as scheduled. Locks shall be furnished with the manufacturer's standard construction key system. Change keys for locks shall be stamped with change number and the inscription "U.S. Property - Do Not Duplicate." Keys shall be supplied as follows:

Locks:	3 change keys each lock.
Master keyed sets:	3 keys each set.
Grand master keys:	3 total.
Blank keys:	12 total.

The keys shall be furnished to the Contracting Officer arranged for key control system storage in sets or subsets as scheduled.

2.7 DOOR CLOSING DEVICES

Door closing devices shall conform to BHMA ANSI/BHMA A156.4, Grade 1. Closing devices shall be products of one manufacturer for each type specified. The opening resistance of closing devices shall not exceed 15 lbf applied at the latch stile.

2.7.1 Surface Type Closers

Surface type closers shall be Grade 1, Series C03000 with options PT-4H, Size 1 or 2 through Size 6, and PT-4D with back check position valve. Except as otherwise specified, sizes shall conform to the manufacturer's published recommendations. Closers for outswinging exterior doors shall have parallel arms or shall be top jamb mounted. Closers for doors close to a wall shall be of narrow projection so as not to strike the wall at the 90-degree open position.

2.8 DOOR CONTROLS - OVERHEAD HOLDERS

Door controls - overhead holders shall conform to BHMA ANSI/BHMA A156.8.

2.9 ARCHITECTURAL DOOR TRIM

Architectural door trim shall conform to BHMA ANSI/BHMA A156.6.

2.10 AUXILIARY HARDWARE

Auxiliary hardware, consisting of door stops, handrail brackets, and coat hooks shall conform to BHMA ANSI/BHMA A156.16.

2.11 MISCELLANEOUS

2.11.1 Metal Thresholds

Thresholds shall conform to BHMA ANSI/BHMA A156.21. Thresholds for exterior doors shall be extruded aluminum of the type indicated and shall provide proper clearance and an effective seal with specified weather stripping. Air leakage rate of weatherstripping shall not exceed 0.5 cubic feet per minute per lineal foot of crack when tested in accordance with ASTM E 283 at standard test conditions.

2.11.2 Rain Drips

Extruded aluminum, not less than 0.07 inch thick, mill finished clear anodized. Door sill rain drips shall be 1-1/2 inches to 1-3/4 inches high by 5/8 inch projection. Overhead rain drips shall be approximately 1-1/2 inches high by 2-1/2 inches projection and shall extend 2 inches on either side of the door opening width.

2.11.3 Aluminum Housed Type Weatherseals

Weatherseals of the type indicated shall consist of extruded aluminum retainers not less than 0.07 inch wall thickness with vinyl, neoprene, silicone rubber, polyurethane or vinyl brush inserts. Aluminum shall be clear (natural) anodized. Weatherseal material shall be of an industrial/commercial grade. Seals shall remain functional through all weather and temperature conditions. Air leakage rate of weatherstripping shall not exceed 0.5 cubic feet per minute per lineal foot of crack when tested in accordance with ASTM E 283 at standard test conditions.

2.11.4 Gasketing

Gasketing shall be a compression type seal, silicon based, self-adhesive product for use on steel door frames. Air leakage rate of weatherstripping shall not exceed 0.5 cubic feet per minute per lineal foot of crack when tested in accordance with ASTM E 283 at standard test conditions.

2.12 FASTENINGS

Fastenings of proper type, size, quantity, and finish shall be supplied with each article of hardware. Machine screws and expansion shields shall be used for attaching hardware to concrete or masonry. Fastenings exposed to the weather in the finished work shall be of brass, bronze, or stainless steel. Sex bolts, through bolts, or machine screws and grommet nuts, where used on reverse-bevel exterior doors equipped with half-surface or full-surface hinges, shall employ one-way screws or other approved

tamperproof screws. Screws for the jamb leaf of half-mortise and full-surface hinges attached to structural steel frames shall be one-way or other approved tamperproof type.

2.13 FINISHES

Unless otherwise specified, finishes shall conform to those identified in BHMA ANSI/BHMA A156.18. Where painting of primed surfaces is required, painting is specified in Section 09900 PAINTING, GENERAL.

PART 3 EXECUTION

3.1 APPLICATION

Hardware shall be located in accordance with DHI-04 and DHI-05, except that deadlocks shall be mounted 48 inches above finish floor. When approved, slight variations in locations or dimensions will be permitted. Application shall be in accordance with DHI-A115.IG or DHI A115-W. Door control devices for exterior doors such as closers and holders, shall be attached to doors with thru bolts and nuts or sex bolts. Alternate fastening methods may be approved by the Contracting Officer when manufacturers' documentation is submitted to verify that the fastening devices and door reinforcements are adequate to resist wind induced stresses. Electric hardware items and access control devices shall be installed in accordance with manufacturer's printed installation procedures.

3.1.1 Door-Closing Devices

Door-closing devices shall be installed and adjusted in accordance with the templates and printed instructions supplied by the manufacturer of the devices. Insofar as practicable, doors opening to or from halls and corridors shall have the closer mounted on the room side of the door.

3.1.2 Thresholds

Thresholds shall be secured with a minimum of three fasteners per single door width and six fasteners per double door width with a maximum spacing of 12 inches. Exterior thresholds shall be installed in a bed of sealant with expansion anchors and stainless steel screws, except that bronze or anodized bronze thresholds shall be installed with expansion anchors with brass screws. Minimum screw size shall be No. 10 length, dependent on job conditions, with a minimum of 3/4 inch thread engagement into the floor or anchoring device used.

3.1.3 Rain Drips

Door sill rain drips shall align with the bottom edge of the door. Overhead rain drips shall align with bottom edge of door frame rabbet. Drips shall be set in sealant and fastened with stainless steel screws.

3.1.4 Weatherseals

Weatherseals shall be located as indicated, snug to door face and fastened in place with color matched metal screws after door and frames have been finish painted. Screw spacing shall be as recommended by manufacturer.

3.1.5 Gasketing

Gasketing shall be installed at the inside edge of the hinge and head and latch sides of door frame. Frames shall be toleranced for a 1/8 inch clearance between door and frame. Frames shall be treated with tape primer prior to installation.

3.2 HARDWARE SETS

HW-1	1 ½ Pr.	Hinges, A8111 4 ½ X 4 ½ - 600
	1 Ea.	Exit Device, Type 3, Function 08 Grade 1
	1 Ea.	Deadbolt, E 2153 Grade 3
	1 Ea.	Coser, C02021
	1 Ea.	Stop, L02101
	1 Ea.	Threshold, J604
	1 Ea.	Weatherstrip Set
	1 Ea.	Drip
HW-2	1 ½ Pr.	Hinges, A8111 4 ½ X 4 ½ - 600
	1 Ea.	Lockset, F-20 Grade 1
	1 Ea.	Closer, C02021
	1 Ea.	Stop, L02143
HW-3	1 ½ Pr.	Hinges, A8111 4 ½ X 4 ½ - 600
	1 Ea.	Lockset, F22 Grade 1
	1 Ea.	Stop, L02143
HW-4	1 ½ Pr.	Hinges, A8111 4 ½ X 4 ½ - 600
	1 Ea.	Lockset, F05 Grade 1
	1 Ea.	Stop, L02143

End of Section

DIVISION 9 - FINISHES

SECTION 09510

ACOUSTICAL CEILINGS

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SECTION 09510

ACOUSTICAL CEILINGS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 635	(1997) Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-In Panel Ceilings
ASTM C 636	(1996) Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panel Ceilings
ASTM E 1264	(1996) Standard Classification for Acoustical Ceiling Products
ASTM E 1414	(1997) Standard Test for Airborne Sound Attenuation Between Rooms Sharing a Common Ceiling Plenum.

1.2 GENERAL REQUIREMENTS

Acoustical treatment shall consist of sound controlling units mechanically mounted on a ceiling suspension system. The unit size, texture, finish, and color shall be as specified. The location and extent of acoustical treatment shall be as shown on the drawings.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Acoustical Ceiling System; GA.

Manufacturer's descriptive data, catalog cuts, and installation instructions.

SD-04 Drawings

Acoustical Ceiling System; GA.

Drawings showing suspension system, method of anchoring and fastening, details, and reflected ceiling plan.

SD-13 Certificates

Acoustical Units; GA.

Certificate attesting that the mineral based acoustical units furnished for the project contains recycled material and showing an estimated percent of such material.

SD-14 Samples

Acoustical Units; GA.

Two samples of each type of acoustical unit and each type of suspension grid tee section showing texture, finish, and color.

1.4 DELIVERY AND STORAGE

Materials shall be delivered to the site in the manufacturer's original unopened containers with brand name and type clearly marked. Materials shall be carefully handled and stored in dry, watertight enclosures. Immediately before installation, acoustical units shall be stored for not less than 24 hours at the same temperature and relative humidity as the space where they will be installed in order to assure proper temperature and moisture acclimation.

1.5 ENVIRONMENTAL REQUIREMENTS

A uniform temperature of not less than 60 degrees F nor more than 85 degrees F and a relative humidity of not more than 70 percent shall be maintained before, during, and after installation of acoustical units.

1.6 SCHEDULING

Interior finish work such as plastering, concrete and terrazzo work shall be complete and dry before installation. Mechanical, electrical, and other work above the ceiling line shall be completed and heating, ventilating, and air conditioning systems shall be installed and operating in order to maintain temperature and humidity requirements.

1.7 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a one year period shall be provided.

1.8 EXTRA MATERIALS

Spare tiles of each color shall be furnished at the rate of 10 tiles for each 1000 tiles installed. Tiles shall be from the same lot as those installed.

PART 2 PRODUCTS

2.1 ACOUSTICAL UNITS

Acoustical units shall conform to ASTM E 1264, Class A, and the following requirements:

2.1.1 Units for Exposed-Grid System

Type: III (mineral fiber with painted finish). Type III acoustical units shall have a minimum recycled material content of 18 percent.

Minimum NRC: 0.55 when tested on mounting No. E-400

Pattern: D.

Nominal size: 24 by 48 inches.

Edge detail: Trimmed and butt.

Finish: Factory-applied standard finish.

Minimum LR coefficient: 0.70.

Minimum CAC: 40.

2.2 SUSPENSION SYSTEM

Suspension system shall be standard exposed-grid, and shall conform to ASTM C 635 for intermediate-duty systems. Surfaces exposed to view shall be aluminum or steel with a factory-applied white baked-enamel finish. Wall molding shall have a flange of not less than 15/16 inch. Inside and outside corner caps. Standard corners shall be provided.

2.3 HANGERS

Hangers shall be galvanized steel wire. Hangers and attachment shall support a minimum 300 pound ultimate vertical load without failure of supporting material or attachment. System shall also conform to Section 05900 SEISMIC SUPPORT FOR MECHANICAL, ELECTRICAL EQUIPMENT AND SUSPENDED CEILING SYSTEMS.

2.4 FINISHES

Acoustical units and suspension system members shall have manufacturer's standard textures, patterns and finishes as specified. Ceiling suspension system components shall be treated to inhibit corrosion.

2.5 COLORS AND PATTERNS

Colors and patterns for acoustical units and suspension system components shall be white.

2.6 CEILING ATTENUATION CLASS AND TEST

Ceiling attenuation class (CAC) range of acoustical units, when required, shall be determined in accordance with ASTM E 1414. Test ceiling shall be continuous at the partition and shall be assembled in the suspension system in the same manner that the ceiling will be installed on the project. System shall be tested with all acoustical units installed.

PART 3 EXECUTION

3.1 INSTALLATION

Acoustical work shall be provided complete with necessary fastenings, clips, and other accessories required for a complete installation. Mechanical fastenings shall not be exposed in the finished work. Hangers shall be laid out for each individual room or space. Hangers shall be placed to support framing around beams, ducts, columns, grilles, and other penetrations through ceilings. Main runners and carrying channels shall be kept clear of abutting walls and partitions. At least two main runners shall be provided for each ceiling span. Wherever required to bypass an object with the hanger wires, a subsuspension system shall be installed, so that all hanger wires will be plumb.

3.1.1 Suspension System

Suspension system shall be installed in accordance with ASTM C 636 and as specified herein. There shall be no hanger wires or other loads suspended from underside of steel decking.

3.1.1.1 Plumb Hangers

Hangers shall be plumb and shall not press against insulation covering ducts and pipes.

3.1.1.2 Splayed Hangers

Where hangers must be splayed (sloped or slanted) around obstructions, the resulting horizontal force shall be offset by bracing, counter splaying, or other acceptable means.

3.1.2 Wall Molding

Wall molding shall be provided where ceilings abut vertical surfaces. Wall molding shall be secured not more than 3 inches from ends of each length and not more than 16 inches on centers between end fastenings. Wall molding springs shall be provided at each acoustical unit in semi-exposed or concealed systems.

3.1.3 Acoustical Units

Acoustical units shall be installed in accordance with the approved installation instructions of the manufacturer. Edges of acoustical units shall be in close contact with metal supports, with each other, and in true alignment. Acoustical units shall be arranged so that units less than one-half width are minimized. Units in exposed-grid system shall be held in place with manufacturer's standard hold-down clips, if units weigh less than 1 psf or if required for fire resistance rating.

3.2 CLEANING

Following installation, dirty or discolored surfaces of acoustical units shall be cleaned and left free from defects. Units that are damaged or improperly installed shall be removed and new units provided as directed.

End of Section

DIVISION 9 - FINISHES

SECTION 09650

RESILIENT FLOORING

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SECTION 09650

RESILIENT FLOORING

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 4078	92(1996) Water Emulsion Floor Polish
ASTM E 648	(1997) Critical Radiant Flux of floor-Covering Systems Using a Radiant Heat Energy Source
ASTM E 662	(1997) Specific Optical Density of Smoke Generated by Solid Materials
ASTM F 1066	(1995a)e1 Vinyl Composition Floor Tile

1.2 FIRE RESISTANCE REQUIREMENTS

Flooring in corridors and exits shall have a minimum average critical radiant flux of 0.22 watts per square centimeter when tested in accordance with ASTM E 648. The smoke density rating shall be less than 450 when tested in accordance with ASTM E 662.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Resilient Flooring and Accessories; GA.

Manufacturer's descriptive data and installation instructions including cleaning and maintenance instructions.

SD-09 Reports

Resilient Flooring and Accessories; GA.

Copies of test reports showing that representative product samples of the flooring proposed for use have been tested by an independent testing laboratory within the past three years or when formulation change occurred and conforms to the requirements specified.

SD-14 Samples

Resilient Flooring and Accessories; GA.

Three samples of each indicated color and type of flooring and base. Sample size shall be minimum 2-1/2 by 4 inches.

1.4 DELIVERY AND STORAGE

Materials shall be delivered to the building site in original unopened containers bearing the manufacturer's name, project identification, and handling instructions. Materials shall be stored in a clean dry area with temperature maintained above 70 degrees F for 2 days prior to installation, and shall be stacked according to manufacturer's recommendations. Materials shall be protected from the direct flow of heat from hot-air registers, radiators and other heating fixtures and appliances.

1.5 ENVIRONMENTAL REQUIREMENTS

Areas to receive resilient flooring shall be maintained at a temperature above 70 degrees F and below 100 degrees F for 2 days before application, during application and 2 days after application. A minimum temperature of 55 degrees F shall be maintained thereafter.

1.6 SCHEDULING

Resilient flooring application shall be scheduled after the completion of other work which would damage the finished surface of the flooring.

1.7 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a one year period shall be provided.

1.8 EXTRA MATERIALS

Extra flooring material of each color and pattern shall be furnished at the rate of 20 tiles for each 1000 tiles installed. Extra materials shall be from the same lot as those installed. Extra base material composed of 20 linear feet of each color shall be furnished.

PART 2 PRODUCTS

2.1 VINYL-COMPOSITION TILE TYPE

Vinyl-composition tile shall conform to ASTM F 1066, Class 2, (through pattern tile), Composition 1, asbestos-free, and shall be 12 inches square and 1/8 inch thick. Tile shall have the color and pattern uniformly distributed throughout the thickness of the tile. Flooring in any one continuous area shall be from the same lot and shall have the same shade and pattern.

2.2 RESILIENT BASE

Base shall be manufacturer's standard rubber or vinyl, coved style (installed with resilient flooring). Base shall be 4 inches high and a minimum 1/8 inch thick. Preformed outside corners shall be furnished.

2.3 TRANSITION STRIP

A vinyl or rubber transition strip tapered to meet abutting material shall be provided.

2.4 ADHESIVE

Adhesive for flooring and wall base shall be as recommended by the flooring manufacturer.

2.5 POLISH

Polish shall conform to ASTM D 4078.

2.6 CAULKING AND SEALANTS

Caulking and sealants shall be as selected by the Contracting Officer.

2.7 MANUFACTURER'S COLOR AND TEXTURE

Color and texture shall be as selected by Contracting Officer.

PART 3 EXECUTION

3.1 EXAMINATION/VERIFICATION OF CONDITIONS

The Contractor shall examine and verify that site conditions are in agreement with the design package and shall report all conditions that will prevent a proper installation. The Contractor shall not take any corrective action without written permission from the Government.

3.2 SURFACE PREPARATION

Flooring shall be in a smooth, true, level plane, except where indicated as sloped. Before any work under this section is begun, all defects such as rough or scaling concrete, low spots, high spots, and uneven surfaces shall have been corrected, and all damaged portions of concrete slabs shall have been repaired as recommended by the flooring manufacturer. Concrete curing compounds, other than the type that does not adversely affect adhesion, shall be entirely removed from the slabs. Paint, varnish, oils, release agents, sealers, waxers, and adhesives shall be removed, as recommended by the flooring manufacturer.

3.3 MOISTURE TEST

The suitability of the concrete subfloor for receiving the resilient flooring with regard to moisture content shall be determined by a moisture test as recommended by the flooring manufacturer.

3.4 INSTALLATION OF VINYL-COMPOSITION TILE

Tile flooring shall be installed with adhesive in accordance with the manufacturer's installation instructions. Tile lines and joints shall be kept square, symmetrical, tight, and even. Edge width shall vary as necessary to maintain full-size tiles in the field, but no edge tile shall be less than one-half the field tile size, except where irregular shaped rooms make it impossible. Flooring shall be cut to, and fitted around, all permanent fixtures, built-in furniture and cabinets, pipes, and outlets. Edge tile shall be cut, fitted, and scribed to walls and partitions after field flooring has been applied.

3.5 INSTALLATION OF FEATURE STRIPS

Edge strips shall be secured with adhesive as recommended by the manufacturer. Edge strips shall be provided at locations where flooring termination is higher than the adjacent finished flooring, except at doorways where thresholds are provided.

3.6 INSTALLATION OF RESILIENT BASE

Wall base shall be installed with adhesive in accordance with the manufacturer's written instructions. Base joints shall be tight and base shall be even with adjacent resilient flooring. Voids along the top edge of base at masonry walls shall be filled with caulk.

3.7 CLEANING

Immediately upon completion of installation of tile in a room or an area, flooring and adjacent surfaces shall be cleaned to remove all surplus adhesive. After installation, flooring shall be washed with a cleaning solution, rinsed thoroughly with clear cold water, and given two coats of polish in accordance with manufacturers written instructions. After each polish coat, floors shall be buffed to an even luster with an electric polishing machine.

3.8 PROTECTION

From the time of laying until acceptance, flooring shall be protected from damage as recommended by the flooring manufacturer. Flooring which becomes damaged, loose, broken, or curled shall be removed and replaced.

End of Section

DIVISION 9 - FINISHES

SECTION 09900

PAINTING, GENERAL

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SECTION 09900

PAINTING, GENERAL

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS (ACGIH)

ACGIH-02	(1996) Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices
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AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 150	(1997a) Portland Cement
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ASTM D 4258	(1988; R 1992) Surface Cleaning Concrete for Coating
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COMMERCIAL ITEM DESCRIPTIONS (CID)

CID A-A-1500	(Rev A) Sealer, Surface (Latex Block Filler)
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CID A-A-1632	(Basic) Varnish, Asphalt
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CID A-A-2246	(Rev B) Paint, Latex (Gloss, Interior)
--------------	--

CID A-A-2247	(Basic) Paint, Latex (Semigloss, Interior)
--------------	--

CID A-A-2248	(Basic) Paint, Latex, (Flat, Interior)
--------------	--

CID A-A-2867	(Basic) Coating, Polyurethane, Single Component Moisture Cure, Aliphatic
--------------	--

CID A-A-2962	(Rev A) Enamel, Alkyd
--------------	-----------------------

CID A-A-2994	(Basic) Primer Coating, Interior, for Walls and Wood
--------------	--

FEDERAL SPECIFICATIONS (FS)

FS TT-C-555	(Rev B; Am 1) Coating, Textured (for Interior and Exterior Masonry Surfaces)
-------------	--

FS TT-E-2784	(Rev A) Enamel (Acrylic-Emulsion, Exterior Gloss and Semigloss) (Metric)
--------------	--

STEEL STRUCTURES PAINTING COUNCIL (SSPC)

SSPC Paint 5	(1995) Zinc Dust, Zinc Oxide and Phenolic Varnish Paint
SSPC Paint 23	(1982) Latex Primer for Steel surfaces
SSPC Paint 25	(1991) Red Iron Oxide, Zinc Oxide, Raw Linseed Oil and Alkyd Primer (Without Lead and Chromate Pigments)
SSPC SP 1	(1982) Solvent Cleaning
SSPC SP 2	(1995) Hand Tool Cleaning
SSPC SP 3	(1995) Power Tool Cleaning
SSPC SP 7	(1994) Brush-Off Blast Cleaning

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Paint; GA.

The names, quantity represented, and intended use for the proprietary brands of materials proposed to be substituted for the specified materials when the required quantity of a particular batch is 50 gallons or less.

SD-06 Instructions

Mixing and Thinning; FIO. Application; FIO.

Manufacturer's current printed product description, material safety data sheets (MSDS) and technical data sheets for each coating system. Detailed mixing, thinning and application instructions, minimum and maximum application temperature, and curing and drying times between coats for epoxy, moisture-curing polyurethane, and liquid glaze coatings. Detailed application instructions for textured coatings shall be provided.

SD-09 Reports

Paint; FIO.

A statement as to the quantity represented and the intended use, plus the following test report for batches in excess of 50 gallons:

- a. A test report showing that the proposed batch to be used meets specified requirements.

- b. A test report showing that a previous batch of the same formulation as the batch to be used met specified requirements, plus, on the proposed batch to be used, a report of test results for properties of weight per gallon, viscosity, fineness of grind, drying time, color, and gloss.

SD-13 Certificates

Lead; FIO. Volatile Organic Compound (VOC) Content; FIO.

Certificate stating that paints for interior use contain no mercurial mildewcide or insecticide. Certificate stating that paints proposed for use contain not more than 0.06 percent lead by weight of the total nonvolatile. Certificate stating that paints proposed for use meet Federal VOC regulations and those of the of the local Air Pollution Control Districts having jurisdiction over the geographical area in which the project is located.

SD-14 Samples

Moisture-Curing Polyurethane; GA.

A complete moisture-curing polyurethane system applied to a panel of the same material as that on which the coating will be applied in the work and for each color specified. The sample panels will be used for quality control in applying the system.

Paint; GA.

While the material is at the site or source of supply, and at a time agreeable to the Contractor and the Contracting Officer, a 1 quart sample of each color and batch, except for quantities of 50 gallons or less, shall be taken by random selection from the sealed containers by the Contractor in the presence of a representative of the Contracting Officer. The contents of the containers to be sampled shall be thoroughly mixed to ensure that the sample is representative. Samples shall be identified by designated name, specification number, manufacturer name and address, batch number, project contract number, intended use, and quantity involved.

1.3 PACKAGING, LABELING, AND STORING

Paints shall be in sealed containers that legibly show the designated name, formula or specification number, batch number, color, quantity, date of manufacture, manufacturer's formulation number, manufacturer's directions including any warnings and special precautions, and name of manufacturer. Pigmented paints shall be furnished in containers not larger than 5 gallons. Paints and thinner shall be stored in accordance with the manufacturer's written directions and as a minimum stored off the ground, under cover, with sufficient ventilation to prevent the buildup of flammable vapors and at temperatures between 40 and 95 degrees F. Paints shall be stored on the project site or segregated at the source of supply sufficiently in advance of need to allow 30 days for testing.

1.4 APPROVAL OF MATERIALS

When samples are tested, approval of materials will be based on tests of the samples; otherwise, materials will be approved based on test reports furnished with them. If materials are approved based on test reports furnished, samples will be retained by the Government for testing should the materials appear defective during or after application. In addition to any other remedies under the contract the cost of retesting defective materials will be at the Contractor's expense.

1.5 ENVIRONMENTAL CONDITIONS

Unless otherwise recommended by the paint manufacturer, the ambient temperature shall be between 45 and 95 degrees F when applying coatings other than water-thinned, epoxy, and moisture-curing polyurethane coatings. Water-thinned coatings shall be applied only when ambient temperature is between 50 and 90 degrees F. Epoxy, and moisture-curing polyurethane coatings shall be applied only within the minimum and maximum temperatures recommended by the coating manufacturer. Moisture-curing polyurethane shall not be applied when the relative humidity is below 30 percent.

1.6 SAFETY AND HEALTH

Work shall comply with applicable Federal, State, and local laws and regulations, and with the ACCIDENT PREVENTION PLAN, including the Activity Hazard Analysis as specified in the CONTRACT CLAUSES. The Activity Hazard Analysis shall include analyses of the potential impact of painting operations on painting personnel and on others involved in and adjacent to the work zone.

1.6.1 Worker Exposures

Exposure of workers to hazardous chemical substances shall not exceed limits established by ACGIH-02, or as required by a more stringent applicable regulation.

1.6.2 Toxic Compounds

Toxic products having ineffective physiological warning properties, such as no or low odor or irritation levels, shall not be used unless approved by the Contracting Officer.

1.6.3 Training

Workers having access to an affected work area shall be informed of the contents of the applicable material data safety sheets (MDSS) and shall be informed of potential health and safety hazard and protective controls associated with materials used on the project. An affected work area is one which may receive mists and odors from the painting operations. Workers involved in preparation, painting and clean-up shall be trained in the safe handling and application, and the exposure limit, for each material which the worker will use in the project. Personnel having a need to use respirators and masks shall be instructed in the use and maintenance of such equipment.

1.6.4 Coordination

Work shall be coordinated to minimize exposure of building occupants, other Contractor personnel, and visitors to mists and odors from preparation, painting and clean-up operations.

PART 2 PRODUCTS

2.1 PAINT

The term "paint" as used herein includes emulsions, enamels, paints, stains, varnishes, sealers, cement-emulsion filler, and other coatings, whether used as prime, intermediate, or finish coat. Paint shall conform to the requirements listed in the painting schedules at the end of this section, except when the required amount of a material of a particular batch is 50 gallons or less, an approved first-line proprietary paint material with similar intended formulation, usage and color to that specified may be used. Additional requirements are as follows:

2.1.1 Colors and Tints

Colors shall be as selected from manufacturer's standard colors, as indicated. Manufacturer's standard color is for identification of color only. Tinting of epoxy and urethane paints shall be done by the manufacturer. Stains shall conform in shade to manufacturer's standard color. The color of the undercoats shall vary slightly from the color of the next coat.

2.1.2 Lead

Paints containing lead in excess of 0.06 percent by weight of the total nonvolatile content (calculated as lead metal) shall not be used.

2.1.3 Chromium

Paints containing zinc chromate or strontium chromate pigments shall not be used.

2.1.4 Volatile Organic Compound (VOC) Content

Paints shall comply with applicable federal, state and local laws enacted to insure compliance with Federal Clean Air Standards and shall conform to the restrictions of the local air pollution control authority.

PART 3 EXECUTION

3.1 PROTECTION OF AREAS NOT TO BE PAINTED

Items not to be painted which are in contact with or adjacent to painted surfaces shall be removed or protected prior to surface preparation and painting operations. Items removed prior to painting shall be replaced when painting is completed. Following completion of painting, workmen skilled in the trades involved shall reinstall removed items. Surfaces contaminated by coating materials shall be restored to original condition.

3.2 SURFACE PREPARATION

Surfaces to be painted shall be clean and free of foreign matter before application of paint or surface treatments. Oil and grease shall be removed prior to mechanical cleaning. Cleaning shall be programmed so that dust and other contaminants will not fall on wet, newly painted surfaces. Exposed ferrous metals such as nail heads on or in contact with surfaces to be painted with water-thinned paints, shall be spot-primed with a suitable corrosion-inhibitive primer capable of preventing flash rusting and compatible with the coating specified for the adjacent areas.

3.2.1 Concrete, Stucco and Masonry Surfaces

Concrete, stucco and masonry surfaces shall be allowed to dry at least 30 days before painting, except concrete slab on grade which shall be allowed to cure 90 days before painting. Surfaces shall be cleaned in accordance with ASTM D 4258. Glaze, efflorescence, laitance, dirt, grease, oil, asphalt, surface deposits of free iron and other foreign matter shall be removed prior to painting. Surfaces to receive polyurethane or epoxy coatings shall be acid-etched or mechanically abraded as specified by the coating manufacturer, rinsed with water, allowed to dry, and treated with the manufacturer's recommended conditioner prior to application of the first coat.

3.2.2 Ferrous Surfaces

Ferrous surfaces including those that have been shop-coated, shall be solvent-cleaned or detergent-washed in accordance with SSPC SP 1. Surfaces that contain loose rust, loose mill scale, and other foreign substances shall be cleaned mechanically with hand tools according to SSPC SP 2, power tools according to SSPC SP 3 or by sandblasting according to SSPC SP 7. Shop-coated ferrous surfaces shall be protected from corrosion by treating and touching up corroded areas immediately upon detection.

3.2.3 Nonferrous Metallic Surfaces

Galvanized, aluminum and aluminum-alloy, lead, copper, and other nonferrous metal surfaces shall be solvent-cleaned or detergent-washed in accordance with SSPC SP 1.

3.3 MIXING AND THINNING

When thinning is approved as necessary to suit surface, temperature, weather conditions, or application methods, paints may be thinned in accordance with the manufacturer's directions. When thinning is allowed, paints shall be thinned immediately prior to application with not more than 1 pint of suitable thinner per gallon. The use of thinner shall not relieve the Contractor from obtaining complete hiding, full film thickness, or required gloss. Thinning shall not cause the paint to exceed limits on volatile organic compounds. Paints of different manufacturers shall not be mixed.

3.3.1 Cement-Emulsion Filler Coat

Cement and aggregate shall be dry-mixed so that uniform distribution and intermixing are obtained. Mixing liquid and one-half of the total amount of water shall be premixed and added gradually to the white portland cement and aggregate with constant stirring until a thick, smooth material is obtained. Emulsion paint shall then be added to the mixture and stirred until uniformity is obtained. The blend shall have a thick, creamy consistency. The remainder of the water shall be added if necessary to obtain a material with adequate application properties. Blending resin emulsion or emulsion paint with any other component shall be done with caution; too rapid an agitation will cause air entrapment and foaming.

3.3.2 Two-Component Systems

Two-component systems shall be mixed in accordance with manufacturer's instructions. Any thinning of the first coat to ensure proper penetration and sealing shall be as recommended by the manufacturer for each type of substrate.

3.4 APPLICATION

Painting practices shall comply with applicable federal, state and local laws enacted to insure compliance with Federal Clean Air Standards. Unless otherwise specified or recommended by the paint manufacturer, paint may be applied by brush, roller, or spray. At the time of application, paint shall show no signs of deterioration. Uniform suspension of pigments shall be maintained during application. Each coat of paint shall be applied so dry film shall be of uniform thickness and free from runs, drops, ridges, waves, pinholes or other voids, laps, brush marks, and variations in color, texture, and finish. Hiding shall be complete. Rollers for applying paints and enamels shall be of a type designed for the coating to be applied and the surface to be coated. Special attention shall be given to insure that all edges, corners, crevices, welds, and rivets receive a film thickness equal to that of

adjacent painted surfaces. Paints, except water-thinned types, shall be applied only to surfaces that are completely free of moisture as determined by sight or touch.

3.4.1 Ventilation

Affected areas shall be ventilated during paint application so that workers exposure to chemical substances shall not exceed limits as established by ACGIH-02, or as required by a more stringent applicable regulation. Interior work zones having a volume of 10,000 cubic feet or less shall be ventilated at a minimum of 2 air exchanges per hour. Ventilation in larger work zones shall be maintained by means of mechanical exhaust. Solvent vapors shall be exhausted outdoors, away from air intakes and workers. Return air inlets in the work zone shall be temporarily sealed before start of work until the coatings have dried.

3.4.2 Respirators

Operators and personnel in the vicinity of operating paint sprayers shall wear respirators.

3.4.3 First Coat

The first coat on plaster, gypsum wallboard, and other surfaces shall include repeated touching up of suction spots or overall application of primer or sealer to produce uniform color and gloss. Excess sealer shall be wiped off after each application. Glazed doors and sashes shall be given the specified coating system within 3 weeks of the time they are glazed, but not before the glazing material has set; paint shall overlay glass about 70 mils all around.

3.4.4 Timing

Surfaces that have been cleaned, pretreated, and otherwise prepared for painting shall be given a coat of the specified first coat as soon as practical after such pretreatment has been completed, but prior to any deterioration of the prepared surface. Sufficient time shall elapse between successive coats to permit proper drying. This period shall be modified as necessary to suit weather conditions. Oil-based or oleoresinous solvent-type paints shall be considered dry for recoating when the paint feels firm, does not deform or feel sticky under moderate pressure of the thumb, and the application of another coat of paint does not cause the undercoat to lift or lose adhesion. Manufacturer's instructions for application, curing and drying time between coats of two-component systems shall be followed.

3.4.5 Fillers

Concrete and masonry surface voids shall be filled; however, surface irregularities need not be completely filled. The dried filler shall be uniform and free of pinholes. Filler shall not be applied over caulking compound.

3.4.5.1 Cement-Emulsion Filler

Immediately before filler application, surfaces shall be dampened uniformly and thoroughly, with no free surface water visible, by several applications of potable water with a fog spray, allowing time between the sprayings for water to be absorbed. Cement-emulsion filler shall be scrubbed into the surface vigorously with a stiff-bristled brush having tampico or palmyra bristles not longer than 2-1/2 inches. At least 24 hours shall elapse before applying exterior emulsion paint over cement-emulsion filler. When the ambient temperature is over 85 degrees F, cement-emulsion filler surfaces shall be

dampened lightly with a fog spray of potable water immediately prior to application of the subsequent paint coat.

3.4.5.2 Latex Filler

Latex filler, CID A-A-1500, shall be applied according to the manufacturer's instructions. Surface voids shall be filled and excess filler shall be removed from the surface with a rubber squeegee. The filler shall be allowed to dry the length of time specified by the manufacturer prior to applying successive coats of paint.

3.4.6 Textured Coating

Application of textured coating, FS TT-C-555, shall be as specified in the manufacturer's printed directions.

3.4.7 Ferrous-Metal Primer

Primer for ferrous-metal shall be applied to ferrous surfaces to receive paint other than asphalt varnish prior to deterioration of the prepared surface. The semitransparent film applied to some pipes and tubing at the mill is not to be considered a shop coat, but shall be overcoated with the specified ferrous-metal primer prior to application of finish coats.

3.5 PIPE COLOR CODE MARKING

Pipes in exposed areas and in accessible pipe spaces shall be provided with color band and titles adjacent to all valves, except those provided at plumbing fixtures, at not more than 40 foot spacing on straight pipe runs, adjacent to change in direction, and on both sides where pipes pass through walls or floors. Color code marking shall be of the color listed in TABLE I and the size listed in TABLE II. The arrows shall be installed adjacent to each band to indicate the direction of flow in the pipe. The legends shall be printed in upper-case black letters as listed in TABLE I. Letter sizes shall be as listed in TABLE II. Marking shall be painted or applied using colored, pressure-sensitive adhesive markers of standard manufacture. Paint shall be as specified for insulated and uninsulated piping.

TABLE I. COLOR CODES FOR MARKING PIPE

Material	Band	Letters and Arrow*	Legend
Cold water (potable)	Green	White	POTABLE WATER
Fire protection water	Red	White	FIRE PR. WATER
Hot water (domestic)	Green	White	H.W.
Hot water recirculating (domestic)	Green	White	H.W.R.
High temp. water supply	Yellow	Black	H.T.W.S.
High temp. water return	Yellow	Black	H.T.W.R.
Boiler feed water	Yellow	Black	B.F.
Low temp. water supply (heating)	Yellow	Black	L.T.W.S.
Low temp. water return (heating)	Yellow	Black	L.T.W.R.
Condenser water supply	Green	White	COND. W.S.
Condenser water return	Green	White	COND. W.R.
Chilled water supply	Green	White	C.H.W.S.
Chilled water return	Green	White	C.H.W.R.

Treated water	Yellow	Black	TR. WATER
Chemical feed	Yellow	Black	CH. FEED
Compressed air	Yellow	Black	COMP. AIR
Natural gas	Blue	White	NAT. GAS
Freon	Blue	White	FREON
Fuel oil	Yellow	Black	FUEL OIL
Steam	Yellow	Black	STM.
Condensate	Yellow	Black	COND.

TABLE II. COLOR CODE MARKING SIZES

Outside Diameter of Pipe Covering (Inches)(inches)	Length of Color Band (Inches)	Arrow Length x Width (Inches)	Size of Legend Letters and Numerals
Less than 1-1/2	8	8 x 2-1/4	1/2
1-1/2 to 2-3/8	8	8 x 2-1/4	3/4
2-1/2 to 7-7/8	12	8 x 2-1/4	1-1/4
8 to 10	24	12 x 4-1/2	2-1/2
Over 10	32	12 x 4-1/2	3-1/2

3.6 MISCELLANEOUS PAINTING

3.6.1 Lettering

Lettering shall be provided as scheduled on the drawings, shall be block type, and shall be black enamel. Samples shall be approved before application.

3.7 SURFACES TO BE PAINTED

Surfaces listed in the painting schedules at the end of this section, other than those listed in paragraph SURFACES NOT TO BE PAINTED, shall be painted as scheduled.

3.8 SURFACES NOT TO BE PAINTED

Surfaces in the following areas shall not be painted: Surfaces of hardware, fittings, and other factory finished items.

3.9 CLEANING

Cloths, cotton waste and other debris that might constitute a fire hazard shall be placed in closed metal containers and removed at the end of each day. Upon completion of the work, staging, scaffolding, and containers shall be removed from the site or destroyed in an approved manner. Paint and other deposits on adjacent surfaces shall be removed and the entire job left clean and acceptable.

3.10 PAINTING SCHEDULES

The following painting schedules identify the surfaces to be painted and prescribe the paint to be used and the number of coats of paint to be applied. Contractor options are indicated by -----or----- between optional systems or coats.

A. EXTERIOR PAINTING SCHEDULE

NOTE: Cement-emulsion filler coat shall be acrylic-based and shall consist of the following ingredients in the proportion stated: white portland cement, ASTM C 150, Type I, 16.5 pounds; aggregate 33.5 pounds; mixing liquid, factory-prepared acrylic containing 46 to 47 percent solids, 0.75 gallon; potable water 1.0 gallon maximum; exterior emulsion paint, FS TT-E-2784 Type III 1.0 gallon. Aggregate shall consist of fine Washed silica sand.

	Surface	First Coat	Second Coat	Third Coat
1.	Concrete, unless Otherwise specified.	FS TT-E-2784 Type III	FS TT-E-2784 Type III	None
2.	Ferrous metal Unless Otherwise Specified	SSPC Paint 5	CID A-A-2962 Type I Class II Grade C	CID A-A-2962 Type 1 Class II Grade C
		- OR -		
		SSPC Paint 25	CID A-A-2962 Type I Class II Grade C	CID A-A-2962 Type 1 Class II Grade C
		- OR -		
		SSPC Paint 23	FS TT-E-2784 Type II	FS TT-E-2784 Type II

NOTE: Commercial blast-cleaning, SSPC SP 6 required. No pretreatment. Maximum total system thickness: 4 mil.

3.	Galvanized Metal	FS TT-E-2784 Type III	FS TT-E-2784 Type II	FS TT-E-2784 Type II
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B. INTERIOR PAINTING SCHEDULE

	Surface	First Coat	Second Coat	Third Coat
1.	Plaster, gypsum board, concrete, and concrete masonry units not requiring a smooth finish, unless otherwise specified.	CID A-A-2994	CID A-A-2247 Type II	None

2.	Concrete masonry units requiring a smooth finish (toilet rooms)	CID A-A-1500	CID A-A-2994 Type II	CID A-A-2246
3.	Ferrous Metal Unless Otherwise Specified	SSPC Paint 25	CID A-A-2962 Type I Class II Grade C	CID A-A-2962 Type I Class II Grade C
-----or-----				
		SSPC Paint 23	FS TT-E-2784 Type I	FS TT-E-2784 Type I
-----or-----				
		CID A-A-2867	CID A-A-2867	None
4.	Ferrous metal in concealed damp spaces or in exposed areas having unpainted adjacent surfaces	CID A-A-1632	None	None
5.	Ferrous metal factory-primed mechanical and electrical equipment.	Two coats of paint as recommended by the equipment manufacturer		None
6.	Galvanized metal:	FS TT-E-2784 Type III	FS TT-E-2784 Type II	None
-----or-----				
		SSPC Paint 5	CID A-A-2962 Type I Class II Grade C	CID A-A-2962 Type I Class II Grade C
-----or-----				
		SSPC Paint 23	FS TT-E-2784 Type I	FS TT-E-2784 Type I

- | | | | | |
|----|---|-------------------|--------------|--------------|
| 7. | Ferrous Metal:
Convector enclosures,
electrical conduit runs:
metallic tubing
uninsulated ducts and pipes,
pipe hangers,
louvers, grilles,
and air outlets,
in areas having
painted adjacent
surfaces. | SSPC Paint 23 | None | None |
| | | | | |
| 8. | Aluminum and Galvanized Surface Metal:
Convector enclosures,
electrical conduit runs
metallic tubing
uninsulated ducts and pipes,
pipe hangers,
louvers, grilles,
and air outlets,
in areas having
painted adjacent
surfaces. | FS TT-E-2784 | CID A-A-2246 | CID A-A-2246 |
| | | | -----or----- | |
| | | | CID A-A-2247 | CID A-A-2247 |
| | | | -----or----- | |
| | | | CID A-A-2248 | CID A-A-2248 |
| | | | | |
| 9. | Stormwater
Pumps & Piping | See Section 15160 | | |

End of Section

DIVISION 9 - FINISHES

SECTION 09940

PAINTING: HYDRAULIC STRUCTURES

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SECTION 09940

PAINTING: HYDRAULIC STRUCTURES

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z87.1 (1989; Z87.1a) Occupational and Educational Eye and Face Protection

ANSI Z358.1 (1998) Emergency Eyewash Shower Equipment

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 304 (1995) N-Butyl Alcohol (Butanol)

ASTM D 1186 (1993) Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to a Ferrous Base

ASTM D 1400 (1994) Nondestructive Measurement of Dry Film Thickness of Nonconductive Coatings Applied to a Nonferrous Metal Base

ASTM D 4417 (1993) Field Measurement of Surface Profile of Blast Cleaned Steel

CODE OF FEDERAL REGULATIONS (CFR)

29 CFR 1910 Occupational Safety and Health Standards

29 CFR 1910.20 Access to Employee Exposure and Medical Records

29 CFR 1910.94 Ventilation

29 CFR 1910.134 Respiratory Protection

29 CFR 1910.146 Permit-required Confined Spaces

29 CFR 1910, Subpart I Personal Protective Equipment

29 CFR 1926 Safety and Health Regulations for Construction

29 CFR 1926.62 Lead

40 CFR 50.6	National Primary and Secondary Ambient Air Quality Standards for Particulate Matter
40 CFR 58, App E	Probe Siting Criteria for Ambient Air Quality Monitoring
40 CFR 60, App A, Mtd 22	Visual Determination of Fugitive Emissions from Material Sources and Smoke Emissions from Flares
40 CFR 261	Identification and Listing of Hazardous Waste
40 CFR 262	Standards Applicable to Generators of Hazardous Waste
40 CFR 262.22	Number of Copies
40 CFR 263	Standards Applicable to Transporters of Hazardous Waste
49 CFR 171, Subchapter C	Hazardous Materials Regulations

ENGINEERING MANUAL (EM)

EM 385-1-1	U.S. Army Corps of Engineers Safety and Health Requirements Manual
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FEDERAL SPECIFICATIONS (FS)

FS TT-P-38	(Rev E) Paint, Aluminum (Ready-Mixed)
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MILITARY SPECIFICATIONS (MS)

MS DOD-P-15328	(Rev D; Am 1; Int Am 2; Notice 1) Primer (Wash), Pretreatment (Formula No. 117 for Metals (Metric)
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NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(1999) National Electrical Code
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NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH (NIOSH)

NIOSH Pub No. 84-100	(1984; Supple 1985, 1987, 1988, & 1990, 1995 4th Edition) NIOSH Manual of Analytical Methods
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STEEL STRUCTURES PAINTING COUNCIL SPECIFICATIONS (SSPC)

SSPC Paint 16	(1991) Coal Tar Epoxy-Polyamide Black (or Dark Red) Paint
SSPC Paint 25	(1991) Red Iron Oxide, Zinc Oxide, Raw Linseed Oil and Alkyd Primer (without Lead and Chromate Pigments)
SSPC SP 1	(1982) Solvent Cleaning
SSPC SP 3	(1989) Power Tool Cleaning

SSPC SP 5	(1991) White Metal Blast Cleaning
SSPC SP 7	(1991) Brush-Off Blast Cleaning
SSPC Guide 6 (CON)	(1994) Containing Debris Generated During Paint Removal Operations

1.2 WORK PERFORMANCE

Work shall be performed in accordance with the requirements of 29 CFR 1910, 29 CFR 1926, EM 385-1-1, and other references as listed herein. Matters of interpretation of the standards shall be submitted to the Contracting Officer for resolution before starting work. Where the regulations conflict, the most stringent requirements shall apply.

1.3 SUBMITTALS

Government approval is required for all submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-08 Statements

Qualifications and Experience; GA.

The Contractor shall provide certification pursuant to paragraph QUALIFICATIONS for all job sites. Submittal of the qualifications and experience of any additional qualified and competent persons the CIH, IH, CSP employs to provide on-site safety and health will also be provided. Acceptance of this submission must be obtained prior to the submission of other required safety and health submittal items.

Accident Prevention Plan; GA.

The requirements included in Section 01 of EM 385-1-1 shall be followed by the Contractor when preparing the Accident Prevention Plan. The plan shall be prepared for all sites and shall include, but is not limited to, each of the topic areas listed in Table 1-1 therein and the requirements of paragraph SAFETY AND HEALTH PROVISIONS; each topic shall be developed in a concise manner to include management and operational aspects.

Confined Space Procedures; GA.

The Contractor shall develop detailed written standard operating procedures for confined spaces for all job sites in accordance with 29 CFR 1910.146 and as further described in this paragraph.

- a. The Contractor shall supply certificates of calibration for all testing and monitoring equipment. The certificates of calibration shall include: type of equipment, model number, date of calibration, firm conducting calibration, and signature of individual certifying calibration.
- b. The procedures shall include methods of inspection of personal protective equipment prior to use.

- c. The procedures shall include work practices and other engineering controls designed to reduce airborne hazardous chemical exposures to a minimum.
- d. The procedures shall include specification of the design and installation of ventilation systems which shall provide adequate oxygen content and provide for the dilution of paint solvent vapor, lead, and other toxic particulates within the confined space. In addition, the Contractor shall include plans to evaluate the adequacy of air flow patterns.

Respiratory Protection Program; GA.

The Contractor shall develop a comprehensive written respiratory protection program for all job sites in accordance with 29 CFR 1910.134, 29 CFR 1926.62, and Section 05.E of EM 385-1-1.

Airborne Sampling Plan; GA.

The Contractor shall develop an Airborne Sampling Plan for all job sites detailing the NIOSH Pub No. 94-113, Factory Mutual, or Underwriters Laboratories approved equipment, equipment calibration procedures, sampling methods, sampling to be performed, and analytical procedures to be used based on the type of work to be performed and anticipated toxic contaminants to be generated. The Contractor shall include the name of the accredited laboratory, listed by the American Industrial Hygiene Association (AIHA), to be used to conduct the analysis of any collected air samples. In addition, the Contractor shall provide the Contracting Officer with a copy of the test results from the laboratory within 5 working days of the sampling date and shall provide results from direct-reading instrumentation on the same day the samples are collected.

Ventilation Assessment; GA.

The Contractor shall develop a plan to provide ventilation assessment for all job sites as required by paragraph PAINT APPLICATION, subparagraph VENTILATION.

Medical Surveillance Plan; GA.

The Contractor shall develop a plan to provide medical surveillance to the workforce for all job sites as required in paragraph MEDICAL STATUS and provide a statement from the examining physician indicating the name of each employee evaluated and any limitations which will preclude the employee from performing the work required. The statement shall include the date of the medical evaluation, the physician's name, signature, and telephone number. Medical records shall be maintained as required by 29 CFR 1910.20.

Waste Classification, Handling, and Disposal Plan; GA.

The Contractor is responsible for assuring the proper disposal of all hazardous and nonhazardous waste generated during the project. Therefore, the Contractor shall develop a Waste Classification, Handling, and Disposal Plan for all job sites in accordance with the requirements of 40 CFR 261 and 40 CFR 262. In addition, the following provisions shall be included:

- a. Hazardous waste shall be placed in closed containers and shall be shielded adequately to prevent dispersion of the waste by wind or water. Any evidence of improper storage shall be cause for immediate shutdown of the project until corrective action is taken.
- b. Nonhazardous waste shall be stored in closed containers separate from hazardous waste storage areas.

- c. All hazardous waste shall be transported by a licensed transporter in accordance with 40 CFR 263 and 49 CFR 171, Subchapter C.
- d. All nonhazardous waste shall be transported in accordance with local regulations regarding waste transportation.
- e. In addition to the number of manifest copies required by 40 CFR 262.22, one copy of each manifest will be supplied to the Contracting Officer prior to transportation.

Containment Plan; GA.

For jobsites with tight controls on emissions but lead is not present, the Contractor shall develop a plan for containing all spent abrasive waste. The containment shall comply with the requirements of SSPC Guide 6 (CON). The plan shall include drawings, load-bearing capacity calculations, and wind load calculations. When the design is such that the spent abrasive is allowed to accumulate in quantities greater than 1,000 pounds, and/or impart a significant wind load on the structure, the Contractor shall have the drawings approved by a registered structural engineer. The drawings and calculations shall be stamped with the engineer's seal. The Contractor shall also identify the type and placement of water booms, methods for anchoring the booms, and the procedures for removing debris.

Ambient Air Monitoring Plan for Particulate Emissions; GA.

For all jobs requiring tight control on emissions where lead is not present, the Contractor shall develop a plan for monitoring emissions of particulate matter 10 microns or less in size (PM-10). The plan shall comply with the requirements of EPA regulation 40 CFR 50.6 and shall include provisions for halting work and correcting the containment in the event unacceptable emissions occur. The positioning of air monitoring equipment shall be in accordance with 40 CFR 58, App E, Subpart (8). In addition, a minimum of two PM-10 monitors shall be used at the project site, one down wind from the project and one in the area of greatest public access (e.g. playground, school yard, or homeowner's yard). When the project is in an area where there are critical receptors nearby, monitoring shall be conducted throughout the entire period that abrasive blasting and cleanup operations are performed. Otherwise, monitoring shall be performed 4 of the first 8 days, and on a regular basis thereafter for a sum total of 25 percent of the time surface preparation and debris cleanup are performed. Failure to meet air quality regulatory limits shall require air monitoring to be repeated immediately after corrective actions have been taken. The Contractor shall also conduct preproject PM-10 monitoring. The preproject PM-10 monitoring shall be conducted a minimum of 2 weeks prior to the beginning of the project. The monitoring shall continue for a minimum of 3 days to establish background levels. A report of the results shall be submitted to the Contracting Officer within 48 hours and shall include:

- a. Name and location of jobsite.
- b. Date of monitoring.
- c. Time of monitoring (i.e., time monitoring begins and ends each day).
- d. Identification and serial number of monitoring units.
- e. Drawing showing specific location of monitoring units.
- f. Drawing showing specific location of paint removal operation and the method of removal or work activity being performed.

- g. Wind direction and velocity.
- h. A flow chart verifying the rate of air flow across the filter throughout the sampling period.
- i. Name and address of laboratory.
- j. Laboratory test procedure.
- k. Laboratory test results.
- l. Signatures of field and laboratory technicians conducting the work.

Visible Emissions; GA.

For all jobs requiring tight control on emissions where lead is not present, the Contractor shall develop a plan monitoring the visible emissions from the project. The time of emissions shall be measured in accordance with 40 CFR 60, App A, Mtd 22. The plan shall also include the provisions for halting work and correcting the containment in the event unacceptable emissions are observed. General statements shall not be used; specific methods, procedures, and details are required. Random emissions from the containment shall not exceed 1 percent of the work day. The Contractor shall document each time that the work is halted due to a violation of the visible emissions criteria. Documentation shall include the cause for shutdown and the corrective action taken to resolve the problem.

SD-14 Samples

Special Paint Formulas; GA.

Samples of special paint formulas, listed in paragraph PAINT FORMULATIONS, shall be submitted. For all epoxy type paints submitted for laboratory testing, a list of ingredient raw materials identifying commercial name, trade designation, manufacturer, batch or lot number, and such other data as may be required shall be furnished.

Specification and Proprietary Paints; GA.

Federal, Military, and Steel Structures Painting Council specification paints are those formulated to meet Federal, military, and industry specifications. When the required quantity of any type is 50 gallons or less, the Contractor can submit:

- a. A certified test report showing the results of required tests made on the material and a statement that it meets all of the specification requirements.
- b. A certified test report showing the results of required tests made on a previous batch of paint produced by the same firm using the same ingredients and formulation except for minor differences necessitated by a color change and a statement that the previous batch met all of the specification requirements. A report of tests on the proposed batch showing the following properties applicable to the material specifications shall be furnished: color, gloss, drying time, opacity, viscosity, weight per gallon, and fineness of grind.
- c. A proprietary paint - When the required quantity of a particular type or color of a paint is 10 gallons or less, a proprietary, name-brand, shelf item paint of the same type and with

similar properties to the material specified may be proposed without sampling. Proprietary paints are any which do not follow the formulas in paragraph PAINT FORMULATIONS or the complete specification requirements of Federal, Military, and Steel Structures Painting Council specifications. To receive consideration, a statement from the supplier that the paint is appropriate as to type, color, and gloss and is a premium grade of paint shall be furnished.

Thinners; GA.

Samples shall be submitted of the thinners which are those solvents used to reduce the viscosity of the paint.

SD-18 Records

Inspections and Operations; GA.

The Contractor shall document and submit records of inspections and operations performed. Submittals shall be made on a timely basis and shall include but are not limited to:

- a. Inspections performed, including the area of the structure involved and the results of the inspection.
- b. Surface preparation operations performed, including the area of the structure involved, the mode of preparation, the kinds of solvent, abrasive, or power tools employed, and whether contract requirements were met.
- c. Thinning operations performed, including thinners used, batch numbers, and thinner/paint volume ratios.
- d. Application operations performed, including the area of the structure involved, mode of application employed, ambient temperature, substrate temperature, dew point, relative humidity, type of paint with batch numbers, elapsed time between surface preparation and application, elapsed time for recoat, condition of underlying coat, number of coats applied, and if specified, measured dry film thickness or spreading rate of each new coating.

1.4 QUALIFICATIONS

Qualifications and experience shall comply with the following.

1.4.1 Certified Professional

The Contractor shall provide a person who is qualified and competent as defined in Section 01 of EM 385-1-1, will develop the required safety and health submittal, and will be responsible for on-site safety and health during the contract period. The person shall be a Certified Industrial Hygienist (CIH), an Industrial Hygienist (IH), or a Certified Safety Professional (CSP) with a minimum of 3 years of demonstrated experience in similar related work. The Contractor shall certify that the Certified Industrial Hygienist (CIH) holds current and valid certification from the American Board of Industrial Hygiene (ABIH), that the IH is considered board eligible by written confirmation from the ABIH, or that the CSP holds current and valid certification from the American Board of Certified Safety Professionals. The CIH, IH, or CSP may utilize other qualified and competent persons, as defined in EM 385-1-1, to conduct on-site safety and health activities as long as these persons have a minimum of

3 years of demonstrated experience in similar related work and are under the direct supervision of the CIH, IH, or CSP.

1.4.2 Certified Laboratory

The Contractor shall provide documentation which includes the name, address, and telephone number of the laboratories to be providing services. In addition, the documentation shall indicate that each laboratory is an EPA National Lead Laboratory Accreditation Program (NLLAP) accredited laboratory and that each is rated proficient in the NIOSH/EPA Environmental Lead Proficiency Analytical Testing Program (ELPAT) and will document the date of current accreditation. Certification shall include accreditation for heavy metal analysis, list of experience relevant to analysis of lead in air, and a Quality Assurance and Quality Control Program.

1.5 SAMPLING AND TESTING

The Contractor shall allow at least 30 days for sampling and testing. Sampling may be at the jobsite or source of supply. The Contractor shall notify the Contracting Officer when the paint is available for sampling. Sampling of each batch shall be witnessed by the Contracting Officer unless otherwise specified or directed. A 1-quart sample of paint and thinner shall be submitted for each batch proposed for use. The sample shall be labeled to indicate formula or specification number and nomenclature, batch number, batch quantity, color, date made, and applicable project contract number. Testing will be performed by the Government. Costs for retesting rejected material will be deducted from payments to the Contractor at the rate of 200 dollars for each sample retested.

1.6 SAFETY AND HEALTH PROVISIONS

Paragraph SAFETY AND HEALTH PROVISIONS supplements the requirements of EM 385-1-1, paragraph (1). In any conflict between Section 01 of EM 385-1-1 and this paragraph, the provisions herein shall govern.

1.6.1 Abrasive Blasting

The Contractor shall comply with the requirements in Section 06.H of EM 385-1-1.

1.6.1.1 Hoses And Nozzles

In addition to the requirements in Section 20 of EM 385-1-1, hoses and hose connections of a type to prevent shock from static electricity shall be used. Hose lengths shall be joined together by approved couplings of a material and type designed to prevent erosion and weakening of the couplings. The couplings and nozzle attachments shall fit on the outside of the hose and shall be designed to prevent accidental disengagement.

1.6.1.2 Workers Other Than Blasters

Workers other than blasting operators working in close proximity to abrasive blasting operations shall be protected by utilizing MSHA/NIOSH-approved half-face or full-face air purifying respirators equipped with high-efficiency particulate air (HEPA) filters, eye protection meeting or exceeding ANSI Z87.1 and hearing protectors (ear plugs and/or ear muffs) providing at least 20 dBA reduction in noise level.

1.6.2 Cleaning with Compressed Air

Cleaning with compressed air shall be in accordance with Section 20.B.5 of EM 385-1-1 and personnel shall be protected as specified in 29 CFR 1910.134.

1.6.3 Cleaning with Solvents

1.6.3.1 Ventilation

Ventilation shall be provided where required by 29 CFR 1910.146 or where the concentration of solvent vapors exceeds 10 percent of the Lower Explosive Limit (LEL). Ventilation shall be in accordance with 29 CFR 1910.94, paragraph (c)(5).

1.6.3.2 Personal Protective Equipment

Personal protective equipment shall be provided where required by 29 CFR 1910.146 and in accordance with 29 CFR 1910, Subpart I.

1.6.4 Pretreatment of Metals and Concrete with Acids

1.6.4.1 Personal Protective Equipment

Personnel shall be protected in accordance with 29 CFR 1910, Subpart I.

1.6.4.2 Emergency Equipment

In addition to the requirements of Section 05 of EM 385-1-1, the Contractor shall provide an eyewash in accordance with ANSI Z358.1, paragraph (6).

1.6.5 Mixing Epoxy Resin Formulations

1.6.5.1 Exhaust Ventilation

Local exhaust ventilation shall be provided in the area where the curing agent and resin are mixed. This ventilation system shall be capable of providing at least 100 linear feet per minute of capture velocity measured at the point where the curing agent and resin contact during mixing.

1.6.5.2 Personal Protective Equipment

Exposure of skin and eyes to epoxy resin components shall be avoided by wearing appropriate chemically resistant gloves, apron, safety goggles, and face shields meeting or exceeding the requirements of ANSI Z87.1.

1.6.5.3 Medical Precautions

Individuals who have a history of sensitivity to epoxy resin systems shall be medically evaluated before any exposure can occur. Individuals who are medically evaluated as exhibiting a sensitivity to epoxy resins shall not conduct work tasks or otherwise be exposed to such chemicals. Individuals who develop a sensitivity shall be immediately removed from further exposure and medically evaluated.

1.6.5.4 Emergency Equipment

A combination unit, comprised of an eyewash and deluge shower, within close proximity to the epoxy resin mixing operation shall be provided in accordance with ANSI Z358.1, paragraph (9).

1.6.6 Paint Application

1.6.6.1 Ventilation

When using solvent-based paint in confined spaces, ventilation shall be provided to exchange air in the space at a minimum rate of 5,000 cubic feet per minute per spray gun in operation. It may be necessary to install both a mechanical supply and exhaust ventilation system to effect adequate air changes within the confined space. All air-moving devices shall be located and affixed to an opening of the confined space in a manner that assures that the airflow is not restricted or short circuited and is supplied in the proper direction. Means of egress shall not be blocked. Ventilation shall be continued after completion of painting and through the drying phase of the operation. If the ventilation system fails or the concentration of volatiles exceeds 10 percent of the LEL (except in the zone immediately adjacent to the spray nozzle), painting shall be stopped and spaces evacuated until such time that adequate ventilation is provided. An audible alarm that signals system failure shall be an integral part of the ventilation system. The effectiveness of the ventilation shall be checked by using ventilation smoke tubes and making frequent oxygen and combustible gas readings during painting operations. Exhaust ducts shall discharge clear of the working areas and away from possible sources of ignition.

1.6.6.2 Explosion Proof Equipment

Electrical wiring, lights, and other equipment located in the paint spraying area shall be of the explosion proof type designed for operation in Class I, Division 1, Group D, hazardous locations as required by the NFPA 70. Electrical wiring, motors, and other equipment, outside of but within 20 feet of any spraying area, shall not spark and shall conform to the provisions for Class I, Division 2, Group D, hazardous locations. Electric motors used to drive exhaust fans shall not be placed inside spraying areas or ducts. Fan blades and portable air ducts shall be constructed of nonferrous materials. Motors and associated control equipment shall be properly maintained and grounded. The metallic parts of air-moving devices, spray guns, connecting tubing, and duct work shall be electrically bonded and the bonded assembly shall be grounded.

1.6.6.3 Further Precautions

- a. Workers shall wear nonsparking safety shoes.
- b. Solvent drums taken into the spraying area shall be placed on nonferrous surfaces and shall be grounded. Metallic bonding shall be maintained between containers and drums when materials are being transferred.
- c. Insulation on all power and lighting cables shall be inspected to ensure that the insulation is in excellent working condition and is free of all cracks and worn spots. Cables shall be further inspected to ensure that no connections are within 50 feet of the operation, that lines are not overloaded, and that they are suspended with sufficient slack to prevent undue stress or chafing.

1.6.6.4 Ignition Sources

Ignition sources, to include lighted cigarettes, cigars, pipes, matches, or cigarette lighters shall be prohibited in area of solvent cleaning, paint storage, paint mixing, or paint application.

1.6.7 Health Protection

1.6.7.1 Respirators

During all spray painting operations, spray painters shall use approved SCBA or SAR (air line) respirators, unless valid air sampling has demonstrated contaminant levels to be consistently within concentrations that are compatible with air-purifying respirator Assigned Protection Factor (APF). Persons with facial hair that interferes with the sealing surface of the facepiece to face seal or interferes with respirator valve function shall not be allowed to perform work requiring respiratory protection. Air-purifying chemical cartridge/canister half- or full-facepiece respirators that have a particulate prefilter and are suitable for the specific type(s) of gas/vapor and particulate contaminant(s) may be used for nonconfined space painting, mixing, and cleaning (using solvents). These respirators may be used provided the measured or anticipated concentration of the contaminant(s) in the breathing zone of the exposed worker does not exceed the APF for the respirator and the gas/vapor has good warning properties or the respirator assembly is equipped with a NIOSH-approved end of service life indicator for the gas(es)/vapor anticipated or encountered. Where paint contains toxic elements such as lead, cadmium, chromium, or other toxic particulates that may become airborne during painting in nonconfined spaces, air-purifying half- and full-facepiece respirators or powered air-purifying respirators equipped with appropriate gas vapor cartridges, in combination with a high-efficiency filter, or an appropriate canister incorporating a high-efficiency filter, shall be used.

1.6.7.2 Protective Clothing and Equipment

All workers shall wear safety shoes or boots, appropriate gloves to protect against the chemical to be encountered, and breathable, protective, full-body covering during spray-painting applications. Where necessary for emergencies, protective equipment such as life lines, body harnesses, or other means of personnel removal shall be used during confined-space work.

1.7 MEDICAL STATUS

Prior to the start of work and annually thereafter, all Contractor employees working with or around paint systems, thinners, blast media, those required to wear respiratory protective equipment, and those who will be exposed to high noise levels shall be medically evaluated for the particular type of exposure they may encounter. The evaluation shall include:

- a. Audiometric testing and evaluation of employees who will work in the noise environments.
- b. Vision screening (employees who use full-facepiece respirators shall not wear contact lenses).
- c. Medical evaluation shall include, but shall not be limited to, the following:
 - (1) Medical history including, but not limited to, alcohol use, with emphasis on liver, kidney, and pulmonary systems, and sensitivity to chemicals to be used on the job.
 - (2) General physical examination with emphasis on liver, kidney, and pulmonary system.

- (3) Determination of the employee's physical and psychological ability to wear respiratory protective equipment and to perform job-related tasks.
- (4) Determination of baseline values of biological indices for later comparison to changes associated with exposure to paint systems and thinners or blast media, which include: liver function tests to include SGOT, SGPT, GGPT, alkaline phosphates, bilirubin, complete urinalysis, EKG (employees over age 40), blood urea nitrogen (bun), serum creatinine, pulmonary function test, FVC, and FEV, chest x-ray (if medically indicated), blood lead (for individuals where it is known there will be an exposure to materials containing lead), other criteria that may be deemed necessary by the Contractor's physician, and Physician's statements for individual employees that medical status would permit specific task performance.
- (5) For lead-based paint removal, the medical requirements of 29 CFR 1926.62 shall also be included.

1.8 CHANGE IN MEDICAL STATUS

Any employee whose medical status has changed negatively due to work related chemical and/or physical agent exposure while working with or around paint systems and thinners, blast media, or other chemicals shall be evaluated by a physician, and the Contractor shall obtain a physicians statement as described in paragraph MEDICAL STATUS prior to allowing the employee to return to those work tasks. The Contractor shall notify the Contracting Officer in writing of any negative changes in employee medical status and the results of the physicians reevaluation statement.

1.9 PAINT PACKAGING, DELIVERY, AND STORAGE

Paints shall be processed and packaged to ensure that within a period of one year from date of manufacture, they will not gel, liver, or thicken deleteriously, or form gas in the closed container. Paints, unless otherwise specified or permitted, shall be packaged in standard containers not larger than 5 gallons, with removable friction or lug-type covers. Containers for vinyl-type paints shall be lined with a coating resistant to solvents in the formulations and capable of effectively isolating the paint from contact with the metal container. Each container of paint or separately packaged component thereof shall be labeled to indicate the purchaser's order number, date of manufacture, manufacturer's batch number, quantity, color, component identification and designated name, and formula or specification number of the paint together with special labeling instructions, when specified. Paint shall be delivered to the job in unbroken containers. Paints that can be harmed by exposure to cold weather shall be stored in ventilated, heated shelters. All paints shall be stored under cover from the elements and in locations free from sparks and flames.

PART 2 PRODUCTS

2.1 SPECIAL PAINT FORMULAS

Special paints shall have the composition as indicated in the formulas listed herein. Where so specified, certain components of a paint formulation shall be packaged in separate containers for mixing on the job. If not specified or otherwise prescribed, the color shall be that naturally obtained from the required pigmentation.

2.2 PAINT FORMULATIONS

Special paint formulas shall comply with the following.

2.2.1 Formula C-200a, Coal Tar-Epoxy (Black) Paint

The paint shall conform to SSPC Paint 16 manufactured with Type 1 pitch. In addition to standard labeling, container labels shall include the term, Corps of Engineers Formula C-200a.

2.3 TESTING

2.3.1 Chromatographic Analysis

Solvents in epoxy paints and thinners shall be subject to analysis by programmed temperature gas chromatographic methods and/or spectrophotometric methods, employing the same techniques that give reproducible results on prepared control samples known to meet the specifications. If the solvent being analyzed is of the type consisting primarily of a single chemical compound or a mixture of two or more such solvents, interpretation of the test results shall take cognizance of the degree of purity of the individual solvents as commercially produced for the paint industry.

PART 3 EXECUTION

3.1 CLEANING AND PREPARATION OF SURFACES TO BE PAINTED

3.1.1 General Requirements

Surfaces to be painted shall be cleaned before applying paint or surface treatments. Deposits of grease or oil shall be removed in accordance with SSPC SP 1, prior to mechanical cleaning. Solvent cleaning shall be accomplished with mineral spirits or other low toxicity solvents having a flashpoint above 100 degrees F. Clean cloths and clean fluids shall be used to avoid leaving a thin film of greasy residue on the surfaces being cleaned. Items not to be prepared or coated shall be protected from damage by the surface preparation methods. Machinery shall be protected against entry of blast abrasive and dust into working parts. Cleaning and painting shall be so programmed that dust or other contaminants from the cleaning process do not fall on wet, newly painted surfaces, and surfaces not intended to be painted shall be suitably protected from the effects of cleaning and painting operations. Welding of, or in the vicinity of, previously painted surfaces shall be conducted in a manner to prevent weld spatter from striking the paint and to otherwise reduce coating damage to a minimum; paint damaged by welding operations shall be restored to original condition. Surfaces to be painted that will be inaccessible after construction, erection, or installation operations are completed shall be painted before they become inaccessible.

3.1.2 Ferrous Surfaces Subject to Normal Exposure

Ferrous surfaces that are to be continuously in exterior or interior atmospheric exposure and other surfaces as directed shall be cleaned by means of power tools or by dry blasting to the brushoff grade. Cleaning and priming shall be done in the shop unless otherwise directed or permitted. Power tool cleaning shall conform to the requirements of SSPC SP 3. Brushoff blast cleaning shall conform to the requirements of SSPC SP 7. Regardless of the overall cleaning method used, welds and adjoining surfaces within a few inches thereof shall be cleaned of weld flux, spatter, and other harmful deposits by blasting, power impact tools, power wire brush, or such combination of these and other methods as may be necessary for complete removal of each type of deposit. The combination of cleaning methods need not include blasting when preparation of the overall surfaces is carried out by the power tool method. However, brush scrubbing and rinsing with clean water, after mechanical cleaning is completed, will be required unless the latter is carried out with thoroughness to remove all soluble alkaline deposits. Wetting of the surfaces during water-washing operations shall be limited to the weld

area required to be treated, and such areas shall be dry before painting. Welds and adjacent surfaces cleaned thoroughly by blasting alone will be considered adequately prepared provided that weld spatter not dislodged by the blast stream shall be removed with impact or grinding tools. All surfaces shall be primed as soon as practicable after cleaning but prior to contamination or deterioration of the prepared surfaces. To the greatest degree possible, steel surfaces shall be cleaned (and primed) prior to lengthy outdoor storage to minimize breakdown of mill scale and consequent rusting.

3.1.3 Ferrous Surfaces Subject to Severe Exposure

Ferrous surfaces subject to extended periods of immersion or as otherwise required shall be dry blast-cleaned to SSPC SP 5. The blast profile, unless otherwise specified, shall be 1.5 to 2.5 mils as measured by ASTM D 4417, Method C. Appropriate abrasive blast media shall be used to produce the desired surface profile and to give an angular anchor tooth pattern. If recycled blast media is used, an appropriate particle size distribution shall be maintained so that the specified profile is consistently obtained. Steel shot or other abrasives that do not produce an angular profile shall not be used. Weld spatter not dislodged by blasting shall be removed with impact or grinding tools and the areas reblasted prior to painting. Surfaces shall be dry at the time of blasting. Blast cleaning to SSPC SP 5 shall be done in the field and, unless otherwise specifically authorized, after final erection. Within 8 hours after cleaning, prior to the deposition of any detectable moisture, contaminants, or corrosion, all ferrous surfaces blast cleaned to SSPC SP 5 shall be cleaned of dust and abrasive particles by brush, vacuum cleaner, and/or blown down with clean, dry, compressed air, and given the first coat of paint.. The surfaces, if shop blasted, shall be shop coated with the first and second coats of the specified paint system. The shop coating shall be maintained in good condition by cleaning and touching up of areas damaged during the construction period. If pinpoint or general rusting appears, surfaces shall be reblasted and repainted at no added cost to the Government. Prior to the field application of subsequent coats, soiled areas of the shop coating shall be thoroughly cleaned and all welds or other unpainted or damaged areas shall be cleaned and coated in a manner to make them equivalent to adjacent, undamaged paint surfaces.

3.1.4 Galvanized, Aluminum, Aluminum Alloy, or Copper Surfaces

Where surfaces are specified to be painted, they shall be first washed with clean mineral spirits and then pretreated with a primer conforming to MS DOD-P-15328 in accordance with the following instructions. The pretreatment primer shall be mixed by adding one volume of acid component (diluent) to four volumes of resin component (base solution) slowly and with constant stirring. After mixing, the material shall be used within 8 hours. The pretreatment primer shall be spray applied at a coverage rate of 250 to 300 square feet per gallon (of resin component) to give a dry film thickness of 0.3 to 0.5 mil. Small areas may be coated by brush or swab. Care shall be exercised in spray application to avoid the deposition of dry particles on the surface. A wet spray shall be maintained at all times by additional thinning with Normal Butanol ASTM D 304. The acid component (diluent), over and above the amount prescribed above, shall not be used for thinning purposes. Surfaces shall receive the first coat of paint after at least 1 but not more than 24 hours drying of the pretreatment primer film.

3.2 PAINT APPLICATION

3.2.1 General

The finished coating shall be free from holidays, pinholes, bubbles, runs, drops, ridges, waves, laps, excessive or unsightly brush marks, and variations in color, texture, and gloss. Application of initial or subsequent coatings shall not commence until the Contracting Officer has verified that atmospheric conditions and the surfaces to be coated are satisfactory. Each paint coat shall be applied in a manner

that will produce an even, continuous film of uniform thickness. Edges, corners, crevices, seams, joints, welds, rivets, corrosion pits, and other surface irregularities shall receive special attention to ensure that they receive an adequate thickness of paint. Spray equipment shall be equipped with traps and separators and where appropriate, mechanical agitators, pressure gauges, pressure regulators, and screens or filters. Air caps, nozzles, and needles shall be as recommended by the spray equipment manufacturer for the material being applied. Airless-type spray equipment may be used only on broad, flat, or otherwise simply configured surfaces, except that it may be employed for general painting if the spray gun is equipped with dual or adjustable tips of proper types and orifice sizes. Airless-type equipment shall not be used for the application of vinyl paints.

3.2.2 Mixing and Thinning

Paints shall be thoroughly mixed, strained where necessary, and kept at a uniform composition and consistency during application. Paste or dry-powder pigments specified to be added at the time of use shall, with the aid of powered stirrers, be incorporated into the vehicle or base paint in a manner that will produce a smooth, homogeneous mixture free of lumps and dry particles. Where necessary to suit conditions of the surface temperature, weather, and method of application, the paint may be thinned immediately prior to use. Thinning shall generally be limited to the addition of not more than 1 pint per gallon of the proper thinner; this general limitation shall not apply when more specific thinning instructions are provided. Paint that has been stored at low temperature, shall be brought up to at least 70 degrees F before being mixed and thinned, and its temperature in the spray tank or other working container shall not fall below 60 degrees F during the application. Paint that has deteriorated in any manner to a degree that it cannot be restored to essentially its original condition by customary field-mixing methods shall not be used and shall be removed from the project site. Paint and thinner that is more than 1 year old shall be resampled and resubmitted for testing to determine its suitability for application.

3.2.3 Atmospheric and Surface Conditions

Paint shall be applied only to surfaces that are above the dew point temperature and that are completely free of moisture as determined by sight and touch. Paint shall not be applied to surfaces upon which there is detectable frost or ice. Except as otherwise specified, the temperature of the surfaces to be painted and of air in contact therewith shall be not less than 45 degrees F during paint application nor shall paint be applied if the surfaces can be expected to drop to 32 degrees F or lower before the film has dried to a reasonably firm condition. During periods of inclement weather, painting may be continued by enclosing the surfaces and applying artificial heat, provided the minimum temperatures and surface dryness requirements prescribed previously are maintained. Paint shall not be applied to surfaces heated by direct sunlight or other sources to temperatures that will cause detrimental blistering, pinholing, or porosity of the film.

3.2.4 Time Between Surface Preparation and Painting

Surfaces that have been cleaned and/or otherwise prepared for painting shall be primed as soon as practicable after such preparation has been completed but, in any event, prior to any deterioration of the prepared surface.

3.2.5 Method of Paint Application

Unless otherwise specified, paint shall be applied by brush or spray to ferrous and nonferrous metal surfaces. Special attention shall be directed toward ensuring adequate coverage of edges, corners, crevices, pits, rivets, bolts, welds, and similar surface irregularities. Other methods of application to metal surfaces shall be subject to the specific approval of the Contracting Officer.

3.2.6 Coverage and Film Thickness

Film thickness or spreading rates shall be as specified hereinafter. Where no spreading rate is specified, the paint shall be applied at a rate normal for the type of material being used. In any event, the combined coats of a specified paint system shall completely hide base surface and the finish coats shall completely hide undercoats of dissimilar color.

3.2.6.1 Measurement on Ferrous Metal

Where dry film thickness requirements are specified for coatings on ferrous surfaces, measurements shall be made with one of the thickness gages listed below. They shall be calibrated and used in accordance with ASTM D 1186. They shall be calibrated using plastic shims with metal practically identical in composition and surface preparation to that being coated, and of substantially the same thickness (except that for measurements on metal thicker than 1/4 inch, the instrument may be calibrated on metal with a minimum thickness of 1/4 inch). Frequency of measurements shall be as recommended for field measurements by ASTM D 1186 and reported as the mean for each spot determination. The instruments shall be calibrated or calibration verified prior to, during, and after each use. Authorized thickness gages:

- a. Mikrotest, Elektro-Physik, Inc.
- b. Inspector Gage, Elcometer Instruments, Ltd.
- c. Positest, Defelsko Corporation
- d. Minitector, Elcometer Instruments, Ltd.
- e. Positector 2000, Defelsko Corporation

3.2.6.2 Measurements on Nonferrous Metal

Where dry film thickness requirements are specified for coatings applied to nonferrous metal surfaces, measurements shall be made with one of the thickness gages listed. They shall be calibrated and used in accordance with ASTM D 1400. Calibration shall be on metal identical in composition and surface preparation to that being coated and of substantially the same thickness (except that for measurements on metal thicker than 1/4 inch, the instrument may be calibrated on metal with a minimum thickness of 1/4 inch). Frequency of measurements shall be as recommended for field measurements by ASTM D 1400 and reported as the mean for each spot determination. The instruments shall be calibrated or calibration verified prior to, during, and after each use. Authorized thickness gages:

- a. Positector 3000 (aluminum and copper only)
- b. Defelsko Corporation Minitector Model 250N, 150N, or 150FN, Elcometer Instruments, Ltd.

3.2.7 Progress of Painting Work

Where field painting on any type of surface has commenced, the complete painting operation, including priming and finishing coats, on that portion of the work shall be completed as soon as practicable, without prolonged delays. Sufficient time shall elapse between successive coats to permit them to dry properly for recoating, and this period shall be modified as necessary to suit adverse weather conditions. Paint shall be considered dry for recoating when it feels firm, does not deform or feel sticky under moderate pressure of the finger, and the application of another coat of paint does not cause film irregularities such as lifting or loss of adhesion of the undercoat. All coats of all painted surfaces shall be unscarred and completely integral at the time of application of succeeding coats. At

the time of application of each successive coat, undercoats shall be cleaned of dust, grease, overspray, or foreign matter by means of airblast, solvent cleaning, or other suitable means. Cement and mortar deposits on painted steel surfaces, not satisfactorily removed by ordinary cleaning methods, shall be brushoff blast cleaned and completely repainted as required. Undercoats of high gloss shall, if necessary for establishment of good adhesion, be scuff sanded, solvent wiped, or otherwise treated prior to application of a succeeding coat. Field coats on metal shall be applied after erection except as otherwise specified and except for surfaces to be painted that will become inaccessible after erection.

3.2.8 Contacting Surfaces

When riveted or ordinary bolted contact is to exist between surfaces of ferrous or other metal parts of substantially similar chemical composition, such surfaces will not be required to be painted, but any resulting crevices shall subsequently be filled or sealed with paint. Contacting metal surfaces formed by high-strength bolts in friction-type connections shall not be painted. Where a nonmetal surface is to be in riveted or bolted contact with a metal surface, the contacting surfaces of the metal shall be cleaned and given three coats of the specified primer. Unless otherwise specified, corrosion-resisting metal surfaces, including cladding therewith, shall not be painted.

3.2.9 Drying Time Prior to Immersion

Minimum drying periods after final coat prior to immersion shall be: epoxy systems at least 5 days, vinyl-type paint systems at least 3 days, and cold-applied coal tar systems at least 7 days. Minimum drying periods shall be increased twofold if the drying temperature is below 65 degrees F and/or if the immersion exposure involves considerable abrasion.

3.2.10 Protection of Painted Surfaces

Where shelter and/or heat are provided for painted surfaces during inclement weather, such protective measures shall be maintained until the paint film has dried and discontinuance of the measures is authorized. Items that have been painted shall not be handled, worked on, or otherwise disturbed until the paint coat is fully dry and hard. All metalwork coated in the shop or field prior to final erection shall be stored out of contact with the ground in a manner and location that will minimize the formation of water-holding pockets; soiling, contamination, and deterioration of the paint film, and damaged areas of paint on such metalwork shall be cleaned and touched up without delay. The first field coat of paint shall be applied within a reasonable period of time after the shop coat and in any event before weathering of the shop coat becomes extensive.

3.2.11 Coal Tar-Epoxy (Black) Paint (Formula C-200a)

3.2.11.1 Mixing

Component B shall be added to previously stirred Component A and thoroughly mixed together with a heavy-duty mechanical stirrer just prior to use. The use of not more than 1 pint of xylene thinner per gallon of paint will be permitted to improve application properties and extend pot life. The pot life of the mixed paint, extended by permissible thinning, may vary from 2 hours in very warm weather to 5 or more hours in cool weather. Pot life in warm weather may be extended by precooling the components prior to mixing; cooling the mixed material; and/or by slow, continuous stirring during the application period. The mixed material shall be applied before unreasonable increases in viscosity take place.

3.2.11.2 Application

Spray guns shall be of the conventional type equipped with a fluid tip of approximately 0.09 inch in diameter and external atomization, seven-hole air cap. Material shall be supplied to the spray gun from a bottom withdrawal pot or by means of a fluid pump; hose shall be 1/2 inch in diameter. Atomization air pressure shall not be less than 80 psi. High-pressure airless spray equipment may be used only on broad, simply configured surfaces. Brush application shall be with a stiff-bristled tool heavily laden with material and wielded in a manner to spread the coating smoothly and quickly without excessive brushing. The coverage rate of the material is approximately 110 square feet per gallon per coat to obtain 20 mils (dry thickness) in a two-coat system. The paint shall flow together and provide a coherent, pinhole-free film. The direction of the spray passes (or finish strokes if brushed) of the second coat shall be at right angles to those of the first where practicable.

3.2.11.3 Subsequent Coats

Except at the high temperatures discussed later in this paragraph, the drying time between coal tar-epoxy coats shall not be more than 72 hours, and application of a subsequent coat as soon as the undercoat is reasonably firm is strongly encouraged. Where the temperature for substrate or coating surfaces during application or curing exceeds or can be expected to exceed 125 degrees F as the result of direct exposure to sunlight, the surfaces shall be shaded by overhead cover or the interval between coats shall be reduced as may be found necessary to avoid poor intercoat adhesion. Here, poor intercoat adhesion is defined as the inability of two or more dried coats of coal tar-epoxy paint to resist delamination when tested aggressively with a sharp knife. Under the most extreme conditions involving high ambient temperatures and sun-exposed surfaces, the drying time between coats shall not exceed 10 hours, and the reduction of this interval to a few hours or less is strongly encouraged. Where the curing time of a coal tar-epoxy undercoat exceeds 72 hours of curing at normal temperatures, 10 hours at extreme conditions, or where the undercoat develops a heavy blush, it shall be given one of the following treatments before the subsequent coat is applied:

- a. Etch the coating surface lightly by brushoff blasting, using fine sand, low air pressure, and a nozzle-to-surface distance of approximately 3 feet.
- b. Remove the blush and/or soften the surface of the coating by wiping it with cloths dampened with 1-methyl-2-pyrrolidone solvent or with Bitumastic 2CB solvent marketed by the Kopcoat, Inc. The solvents may be applied to the surface by fog spraying followed by wiping, but any puddles of solvent must be mopped up immediately after they form. The subsequent coat shall be applied in not less than 15 minutes or more than 3 hours after the solvent treatment.

3.2.11.4 Ambient Temperature

Coal tar-epoxy paint shall not be applied when the receiving surface or the ambient air is below 50 degrees F nor unless it can be reasonably anticipated that the average ambient temperature will be 50 degrees F or higher for the 5-day period subsequent to the application of any coat.

3.2.11.5 Safety

In addition to the safety provisions in paragraph SAFETY AND HEALTH PROVISIONS, other workmen as well as painters shall avoid inhaling atomized particles of coal tar-epoxy paint and contact of the paint with the skin.

3.3 PAINT SYSTEMS APPLICATION

The required paint systems and the surfaces to which they shall be applied are shown in this paragraph, and/or in the drawings. Supplementary information follows.

3.3.1 Fabricated and Assembled Items

Items that have been fabricated and/or assembled into essentially their final form and that are customarily cleaned and painted in accordance with the manufacturer's standard practice will be exempted from equivalent surface preparation and painting requirements described herein, provided that:

- a. Surfaces primed (only) in accordance with such standard practices are compatible with specified field-applied finish coats.
- b. Surfaces that have been primed and finish painted in accordance with the manufacturer's standard practice are of acceptable color and are capable of being satisfactorily touched up in the field.
- c. Items expressly designated herein to be cleaned and painted in a specified manner are not coated in accordance with the manufacturer's standard practice if different from that specified herein.

3.3.2 Surface Preparation

The method of surface preparation and pretreatment shown in the tabulation of paint systems is for identification purposes only. Cleaning and pretreatment of surfaces prior to painting shall be accomplished in accordance with detailed requirements previously described.

3.3.3 System No. 2

The first coat shall be brush or spray applied in the shop or field as indicated at a maximum spreading rate of 600 square feet per gallon and touched up in the field as necessary to maintain its integrity at all times. The second or third coats of the system shall be applied in the field at a maximum spreading rate of 450 square feet per gallon. Prior to applying field coats, all field welds, other bare metal, and damaged areas of the shop-primed surfaces shall be cleaned and primed as previously specified except that application shall be by brush.

3.3.4 System No. 6

Paint shall be spray or brush applied with a minimum of two coats to provide a minimum total thickness at any point of 16 mils. The specified film thickness shall be attained in any event, and any additional (beyond two) coats needed to attain specified thickness shall be applied at no additional cost to the Government.

3.3.5 Protection of Nonpainted Items and Cleanup

Walls, equipment, fixtures and all other items in the vicinity of the surfaces being painted shall be maintained free from damage by paint or painting activities. Paint spillage and painting activity damage shall be promptly repaired.

3.4 PAINTING SCHEDULES

SYSTEM NO. 2

Items or surfaces to be coated: Storm Water Pumps above E1.306.0

SURFACE PREPARATION	1st COAT	2nd COAT	3rd COAT
Power tool or brushoff blast cleaning	SSPC Paint 25 Type I	FS TT-P-38 (Aluminum)	FS TT-P-38 (Aluminum)

SYSTEM NO. 6

Items or surfaces to be coated: Storm Water Pumps below E1.306.0, Formed Suction Intakes, Stop Logs, Sluice Gates, Trash Racks, and Mechanical Trash Rakes.

SURFACE PREPARATION	1st COAT	2nd COAT	3rd COAT
White metal blast cleaning	Coal tar- epoxy C-200a (black)	Coal tar- epoxy C-200a (black)	Coal tar- epoxy C-200a (black) (if needed to attain required thickness)

End of Section

DIVISION 10 - SPECIALTIES

SECTION 10440

INTERIOR SIGNAGE

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SECTION 10440

INTERIOR SIGNAGE

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z97.1	(1984; Rev 1994) Safety Performance Specifications and Methods of Test for Safety Glazing Materials Used in Buildings
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1.2 GENERAL

Interior signage shall be of the sizes and types shown on the drawings, shall conform to the requirements specified herein, and shall be provided at the locations indicated. Signs shall be complete with lettering, framing as detailed, and related components for a complete installation. Signs shall be the standard product of a manufacturer regularly engaged in the manufacture of such products and shall essentially duplicate signs that have been in satisfactory use at least 2 years prior to bid opening.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Interior Signage; GA.

Manufacturer's descriptive data, catalogs cuts, installation and cleaning instructions.

SD-04 Drawings

Interior Signage; GA.

Drawings showing elevations of each type of sign, dimensions, details and methods of mounting or anchoring, shape and thickness of materials, and details of construction. A schedule showing the location of each sign type shall be included.

SD-14 Samples

Interior Signage; GA.

One sample of each of the following sign types showing typical quality and workmanship. The samples may be installed in the work, provided each sample is identified and location recorded.

- a. Direction sign.
- b. Door sign.

Two samples of manufacturer's standard color chips for each material requiring color selection.

1.4 DELIVERY AND STORAGE

Materials shall be delivered to the jobsite in manufacturer's original packaging and stored in a clean, dry area.

PART 2 PRODUCTS

2.1 COLOR, FINISH, AND CONTRAST

Color shall be as selected from manufacturer's standard. Characters and symbols shall contrast with their background - either light characters on a dark background or dark characters on a light background.

2.2 CHARACTER PROPORTIONS AND HEIGHTS

Letters and numbers on signs shall have a width-to-height ratio between 3:5 and 1:1 and a stroke-width-to-height ratio between 1:5 and 1:10. Characters and numbers on signs shall be sized according to the viewing distance from which they are to be read. The minimum height is measured using an upper case letter X. Lower case characters are permitted. Suspended or projected overhead signs shall have a minimum character height of 3 inches.

2.3 PLAQUE SIGNS

Plaque signs shall be a modular type signage system. Signs shall be fabricated of acrylic plastic conforming to ANSI Z97.1.

2.3.1 Standard Modular Plaque Signs

Plaque signs shall consist of matte finish acrylic plastic, thickness and size as shown. Frames shall be aluminum. Corners of signs shall be squared.

2.3.2 Type of Mounting For Plaque Signs

Extruded aluminum brackets, in finish as shown, shall be furnished for hanging, projecting, and double-sided signs. Mounting for framed, hanging, and projecting signs shall be by holes and screws. Surface mounted signs shall be provided with countersunk mounting holes in plaques and mounting screws. Sign inserts shall be provided with 1/16 inch thick foam tape.

2.4 GRAPHICS

2.4.1 Graphics Application

Signage graphics shall conform to one of the following:

- a. Pressure sensitive precision cut vinyl letters shall be provided. Edges and corners of finished letter forms and graphics shall be true and clean.
- b. Message shall be acrylic letters 1/8 inch thick and chemically welded to 0.125 inch thick acrylic backup sheet.

2.4.2 Messages

See drawings and schedule for message content, Typeface: Helvetica medium. Type size as indicated.

2.5 ANCHORS AND FASTENERS

Exposed anchor and fastener materials shall be compatible with metal to which applied and shall have matching color and finish. Anchorage system shall be of the type recommended by the manufacturer of the indicated substrate. Where recommended by signage manufacturer, foam tape pads may be used for anchorage. Foam tape pads shall be minimum 1/16 inch thick closed cell vinyl foam with adhesive backing. Adhesive shall be transparent, long aging, high tech formulation on two sides of the vinyl foam. Adhesive surfaces shall be protected with a 5 mil green flatstock treated with silicone. Foam pads shall be sized for the signage as per signage manufacturer's recommendations.

2.6 FABRICATION AND MANUFACTURE

2.6.1 Workmanship

Holes for bolts and screws shall be drilled or punched. Drilling and punching shall produce clean, true lines and surfaces. Exposed surfaces of work shall have a smooth finish and exposed riveting shall be flush. Fastenings shall be concealed where practicable.

2.6.2 Dissimilar Materials

Where dissimilar metals are in contact, the surfaces will be protected to prevent galvanic or corrosive action.

PART 3 EXECUTION

3.1 INSTALLATION

Signs shall be installed in accordance with approved manufacturer's instructions at locations shown on the drawings. Signs shall be installed plumb and true at mounting heights indicated, and by method shown or specified. Signs on doors or other surfaces shall not be installed until finishes on such surfaces have been installed.

3.1.1 Anchorage

Anchorage shall be in accordance with approved manufacturer's instructions. Anchorage not otherwise specified or indicated shall include slotted inserts, expansion shields, and power-driven fasteners when approved for concrete; toggle bolts and through bolts for masonry; machine carriage bolts for steel; lag bolts and screws for wood.

3.1.2 Protection and Cleaning

The work shall be protected against damage during construction. Hardware and electrical equipment shall be adjusted for proper operation. Glass, frames, and other sign surfaces shall be cleaned in accordance with the manufacturer's approved instructions.

End of Section

DIVISION 10 - SPECIALTIES

SECTION 10800

TOILET ACCESSORIES

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SECTION 10800

TOILET ACCESSORIES

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 1036 (1997) Flat Glass

COMMERCIAL ITEM DESCRIPTIONS (CID)

CID A-A-2380 (Basic) Dispenser, Paper Towel

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation, submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Finishes; GA. Accessory Items; GA.

Manufacturer's descriptive data and catalog cuts indicating materials of construction, fasteners proposed for use for each type of wall construction, mounting instructions, and operation instructions.

1.3 DELIVERY, STORAGE, AND HANDLING

Toilet accessories shall be wrapped for shipment and storage, delivered to the jobsite in manufacturer's original packaging and stored in a clean, dry area protected from construction damage and vandalism.

PART 2 PRODUCTS

2.1 MANUFACTURED UNITS

Toilet accessories shall be provided where indicated in accordance with paragraph SCHEDULE. Each accessory item shall be complete with the necessary mounting plates and shall be of sturdy construction with corrosion resistant surface.

2.1.1 Anchors and Fasteners

Anchors and fasteners shall be capable of developing a restraining force commensurate with the strength of the accessory to be mounted and shall be suited for use with the supporting construction. Exposed fasteners shall have oval heads and shall be finished to match the accessory.

2.1.2 Finishes

Except where noted otherwise, finishes on metal shall be provided as follows:

<u>Metal</u>	<u>Finish</u>
Stainless steel	No. 4 satin finish
Carbon steel, copper alloy, and brass	Chromium plated, bright

2.2 ACCESSORY ITEMS

Accessory items shall conform to the requirements specified below.

2.2.1 Grab Bar (GB)

Grab bar shall be 18 gauge, 1-1/4 inches OD Type 304 stainless steel. Grab bar shall be form and length as indicated. Exposed mounting flange shall have set screw mounting holes concealed on the lip of the flange. Grab bar shall have satin finish. Installed bars shall be capable of withstanding a 500 pound vertical load without coming loose from the fastenings and without obvious permanent deformation. Space between wall and grab bar shall be 1/2 inch.

2.2.2 Glass Mirrors (GM)

Glass for mirrors shall be Type I transparent flat type, Class 1-clear, glazing quality q1 1/4 inch thick conforming to ASTM C 1036. Glass shall be coated on one surface with silver coating, copper protective coating, and mirror backing paint. Silver coating shall be highly adhesive pure silver coating of a thickness which shall provide reflectivity of 83 percent or more of incident light when viewed through 1/4 inch thick glass, and shall be free of pinholes or other defects. Copper protective coating shall be pure bright reflective copper, homogeneous without sludge, pinholes or other defects, and shall be of proper thickness to prevent "adhesion pull" by mirror backing paint. Mirror backing paint shall consist of two coats of special scratch and abrasion-resistant paint and shall be baked in uniform thickness to provide a protection for silver and copper coatings which will permit normal cutting and edge fabrication.

2.2.3 Paper Towel Dispenser (PTD)

Paper towel dispenser shall conform to CID A-A-2380, Type I, shall be constructed of not less than 22 gauge carbon steel 0.269 inch Type 304 stainless steel, and shall be surface mounted. Dispenser shall have a towel compartment and a mirror door. Locking mechanism shall be tumbler key lock.

2.2.4 Soap Dispenser (SD)

Soap dispenser shall be surface mounted, liquid type consisting of a vertical Type 304 stainless steel tank with holding capacity of 40 fluid ounces with a corrosion-resistant all-purpose valve that dispenses liquid soaps, lotions, detergents and antiseptic soaps, chromium plated zinc die casting, shall contain a swap feed mechanism and an agitator designed to break up powdered soap, and shall have a minimum capacity of 32 ounces.

2.2.5 Shelf, Metal, Light Duty (SMLD)

Light duty metal shelf shall be supported between brackets or on brackets. Brackets shall prevent lateral movement of the shelf. Shelf shall be 24 inches long. Shelf and brackets shall be stainless steel.

2.2.6 Toilet Tissue Dispenser (TTD)

Toilet tissue holder shall be Type II - surface mounted with two rolls of tissue stacked vertically. Cabinet shall be stainless steel, satin finish.

2.2.7 Waste Receptacle (WR)

Waste receptacle shall be 22 gauge Type 304 stainless steel, designed for surface mounting. Reuseable liner, of the type standard with the receptacle manufacturer, shall be provided. Capacity shall be not less than 1.5 cubic feet.

PART 3 EXECUTION

3.1 INSTALLATION

Toilet accessories shall be securely fastened to the supporting construction in accordance with the manufacturer's approved instructions. Accessories shall be protected from damage from the time of installation until acceptance.

3.2 SCHEDULE

Accessories required as shown on drawings.

End of Section

DIVISION 11 - EQUIPMENT

SECTION 11212

SPEED REDUCERS FOR STORM WATER PUMPS

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SECTION 11212

SPEED REDUCERS FOR STORM WATER PUMPS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABEMA)

ABEMA 9 (1990) Load Ratings and Fatigue Life for Ball Bearings

ABEMA 11 (1990) Load Ratings and Fatigue Life for Roller Bearings

AMERICAN GEAR MANUFACTURERS ASSOCIATION (AGMA)

AGMA 6010-F (1997; Errata Nov 1991) Standard for Spur, Helical, Herringbone, and Bevel Enclosed Drives

AGMA 6023-A (1988; Errata Jul 1991; R 1993) Design Manual for Enclosed Metric Module Gear Drives

AGMA 6025-C (1990) Sound for Enclosed Helical, Herringbone, and Spiral Bevel Gear Drives

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B31.1 (1998) Power Piping

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250 (1997) Enclosures for Electrical Equipment (1000 Volts Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (1999) National Electrical Code

NATIONAL FLUID POWER ASSOCIATION (NFLPA)

NFLPA T3.10.8.8 R1 (1990; R 1994) Hydraulic Fluid Power - Filters - Multi-Pass Method for Evaluating Filtration Performance

1.2 GENERAL REQUIREMENTS

1.2.1 Standard Products

Materials and equipment shall be the standard products of manufacturers regularly engaged in the production of gear reducers for vertical pump drives and shall essentially duplicate products which have been in prior satisfactory use for at least 2 years prior to bid opening. All products shall be new.

1.2.2 Delivery and Storage

Material and equipment shall be protected from weather, humidity, temperature variation, dirt, dust, and other contaminants during delivery and storage.

1.3 SYSTEM DESCRIPTION

1.3.1 General Product Requirements

The speed reducers shall be designed and manufactured by a firm that is regularly engaged in the manufacture of speed reducers of the type utilized for these installations. The reducer shall display the certified manufacturer's AGMA insignia as evidence of conformance to these standards. The nameplate shall bear the manufacturer's name, model designation, serial number, unit rating, application factor, reduction ratio, and other applicable information. The speed reducer shall be single reduction spiral bevel gear type equipped with thrust bearings to make the speed reducer suitable for use with a vertical impeller pump. Where upthrust is possible during pump startup or shutdown, the thrust bearing shall be designed to resist this load. The speed reducer shall be able to withstand all of the specified operating conditions without damage. A backstop shall be provided to prevent reverse rotation of the pump. The gear reducer shall conform to the requirements of AGMA 6010-E or AGMA 6023-A as applicable.

1.3.2 Design Conditions

1.3.2.1 Operating Conditions

The Contractor shall obtain the operating conditions from the pump and prime mover suppliers. Operating conditions which shall be considered include (as a minimum): maximum input power, motor or engine speed, speed reducer ratio, maximum pump reverse overspeed, low-speed shaft downward thrust including weight, low-speed shaft momentary upward thrust during startup or shutdown (if applicable), high-speed shaft direction of rotation, low-speed shaft direction of rotation, overhung load, motor stall torque, or maximum engine overload torque transmitted through the clutch, reverse torque load on the backstop.

1.3.2.2 Runaway

The speed reducer shall be designed to withstand backstop failure and maximum pump reverse runaway speed for a period of 30 minutes.

1.3.2.3 Critical Speeds

Dynamic analysis of the pump, reducer, and motor assembly shall be performed by the pump manufacturer. The reducer manufacturer shall coordinate with the pump manufacturer in performing the dynamic analysis. The reducer manufacturer shall make any design modifications to the reducer

which are necessary to avoid resonances in the system. A torsional or lateral natural frequency within 25 percent of normal operating speed of any shaft or gear mesh frequency is unacceptable.

1.3.3 Arrangement

The arrangement shall use a true hollow low-speed shaft where the pump shaft passes concentrically through the reducer shaft allowing finite impeller elevation adjustment. The speed reducer input shaft shall be connected to the motor shaft by a flexible coupling. The Contractor shall ensure compatibility and fit of the reducer high- and low-speed shafts with that of the pump and prime mover. The speed reducer mounting shall be designed to permit removal of the reducer and reinstallation without requiring realignment of the reducer and shafting. Before assembly, each gear and shaft assembly shall be dynamically balanced.

1.4 SUBMITTALS

Government approval is required for all submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

System Description; GA. Bearings; GA. Gears; GA. Shafts; GA. Couplings; GA. Backstop; GA. Housing; GA. Lubrication System; GA. Instrumentation; GA. Speed Reducers and Related Lubricating and Auxiliary Equipment; GA. Lubricant; GA.

Complete computations, design loads, and catalog data.

SD-04 Drawings

Reducer Drawings; GA. Lubrication System; GA. Instrumentation; GA.

Detail drawings of sufficient size for easy reading and consisting of a complete list of equipment and materials, including manufacturer's descriptive and technical literature; performance charts and curves; catalog cuts; and installation instructions. Drawings shall show proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of work including clearances for maintenance and operation.

SD-09 Reports

Shop Testing; GA. Field Testing; GA.

A shop test report fully documenting the test.

A field test report documenting all data for load and speed measurement, lubrication oil temperature and flow, cooling water temperature and flow, gear contact patterns, adjustment of component settings, and otherwise showing compliance with specified performance criteria.

SD-19 Operation and Maintenance Manuals

Operation and Maintenance Manual; GA.

The Operation and Maintenance Manual shall provide detailed startup and operating procedures, lubrication instructions, installation and alignment procedures, routine maintenance requirements and procedures, complete detailed procedures for disassembly and assembly of the reducer, parts list for all parts detailed, assembly drawings of the reducer showing all parts, suppliers for all parts, settings and adjustment for protective devices, and a list of all tools, handling devices, and spare parts furnished.

PART 2 PRODUCTS

2.1 GENERAL

The reducer assembly shall be rated in accordance with AGMA 6010-E or AGMA 6023-A as applicable. The unit rating shall be equal to or exceed the maximum input power times an application factor. The application factor shall be 1.25 for reducers driven by electric motors.

2.2 BEARINGS

2.2.1 Thrust Bearings

Thrust bearings shall be either hydrodynamic fluid film type or antifriction type. Antifriction thrust bearings shall be either tapered roller or spherical roller type. The thrust bearing shall be sized for the pump thrust plus the weight of the impeller and shaft. The thrust bearing size and arrangement shall be coordinated with the pump supplier. The bearings shall be able to sustain continuous operational load as well as startup and shutdown loads. Hydrodynamic fluid film thrust bearings shall use pivoted segmental shoes with the babbitted face surfaced as recommended by the bearing manufacturer to maintain an optimum oil film.

2.2.2 Radial Bearings

Radial bearings for spiral bevel and parallel shaft reducers shall be antifriction type.

2.2.3 Hydrodynamic Fluid Film Bearings

The bearings shall be designed to have a minimum oil film thickness of 0.0005 inch under the most severe operating conditions. The bearing loads shall not exceed 350 psi for the maximum load. Where hydrodynamic fluid film thrust bearings are used, suitable hydrostatic lift provisions shall be made if required to prevent bearing damage during startup. Thrust bearings shall be provided with either spring loaded or embedded instrumentation to monitor operating temperatures.

2.2.4 Antifriction Bearings

Antifriction bearings shall be rated for an L-10 life of 100,000 hours at the operating load of the reducer. Ball bearing load ratings shall conform to ABEMA 9. Roller bearing load ratings shall conform to ABEMA 11.

2.3 GEARS

Right angle gearing shall be of the spiral bevel design. Spiral bevel, helical, and double helical gears shall be gas nitrided or carburized, hardened and ground. The pinion or gear of each helical set shall be crowned to eliminate end loading. For helical gears, standard normal diametral pitches shall be used. In addition to rating the gears according to AGMA 6010-E or AGMA 6023-A as applicable, gear

stresses shall not exceed 80 percent of yield strength for any overload, motor stall, or engine overload condition. No less than 350 percent of motor rated torque shall be used for the motor stall condition.

2.4 SHAFTS

Each shaft shall be heat treated alloy steel. Input shaft size and configuration shall be compatible with the motor. Output shaft size and configuration shall be compatible with the pump. Welded shafts are not acceptable.

2.5 COUPLINGS

The speed reducer shall be connected to the motor by flexible coupling. The couplings shall have a service factor of 2 based on maximum rated load. In addition, at maximum overload conditions, stresses shall not exceed 80 percent of yield strength. Couplings shall transmit torque by means of a steel grid spring fitted into grooves in the periphery of the coupling hubs or by means of external gears on hubs engaging in internal gears on the coupling sleeves or by hubs engaged with flexible self-lubricating members. Couplings with sleeves held in place by snap rings are not acceptable. Couplings shall be enclosed and sealed to exclude contaminants and retain the lubricant under both static and operating conditions. The couplings shall be dynamically balanced to AGMA balance classification 7 or better and shall be grease lubricated unless self-lubricated.

2.6 BACKSTOPS

A backstop shall be provided on the output shaft to prevent reverse rotation of the pump. The backstop shall be sized for the resulting torque at the reducer during maximum reverse flow at pump and a service factor of 2.0 shall be applied to the manufacturer's published rating. The backstop shall be of a type with cylindrical rollers on inclined cam planes or drop-pin type. The backstop shall be mounted with the outer race moving and the inner race fixed. The backstop shall operate at a temperature of less than 160 degrees F under all operating conditions with an ambient temperature up to 100 degrees F. The backstop shall be provided with a circulating oil lubrication system and shall have sufficient flow rate to provide the required cooling. The lubrication system may be part of the gear reducer lubrication system.

2.7 HOUSING

2.7.1 General

The housing shall be cast or fabricated steel, stress relieved prior to machining, and reinforced to carry all applied loads and to maintain gear alignment. The housing shall be rigidly bolted to the reducer baseplate. It shall have a minimum of four jack bolts to facilitate alignment. The housing bottom shall be machined. The interior of the reducer shall be painted with an oil compatible coating. The exterior shall be painted with the manufacturer's standard coating system. Color shall be light gray. The housing shall have an oil fill connection and a drain connection with a magnetic plug. Lifting lugs shall be provided for lifting the entire reducer assembly and any subassembly or component which cannot be lifted using web slings.

2.7.2 Seals

Vertical down output shafts shall have a drywell design seal. The input shaft shall have a lip seal to prevent leakage of oil and exclude dirt. Lip seals shall utilize hardened steel wear sleeves to preclude shaft repair or replacement if the seal wears the shaft.

2.7.3 Inspection Covers

The housing shall have inspection holes with cover plates located above the maximum oil level to permit viewing of gear teeth allowing evaluation of the contact patterns of each gear mesh and to allow inspection of internal features of the lubrication system.

2.8 LUBRICATION SYSTEM

2.8.1 General

The speed reducer shall be provided with an oil lubrication system that will provide continuous lubrication to the gears, bearings, and oil lubricated-type backstop. The system shall consist of an oil circulating pump, air heat exchanger, piping, filters, and controls. Each reducer shall be provided with its own system. The maximum oil sump temperature at rated speed and load shall be 160 degrees F at an ambient temperature of 100 degrees F.

2.8.2 Oil Pumps

The oil pumps shall be positive displacement type. Each pump shall have a relief valve which discharges to the sump. The pump shall be reversible so it continues to function during a runaway condition.

2.8.3 Prelubrication Pump

The reducer shall be prelubricated prior to startup. The prelubrication pump shall be motor-driven positive displacement, type where antifriction thrust bearings are used. The electric motor-driven pump shall deliver sufficient pressure to lift the thrust bearing runner from the shoes. The pump shall operate in manual and automatic modes. In automatic mode, the prelubrication pump shall supply oil prior to reducer startup, shall continue operation at least 30 seconds after reducer startup, then shall automatically shut down. In manual mode, the prelubrication pump shall be started and stopped from a local push button station on control panel. Available power for the pump and controls will be 480 V, 3 Ph, 60 Hz and 120 V, 1 Ph, 60 Hz. The pump shall supply oil through the lubrication system prior to reducer startup. The pump shall utilize zero-leakage check valves to isolate it from the lubrication system during operation of the reducer. The prelubrication system shall not require valve operation to execute the prelubrication cycle or to return to normal operation.

2.8.4 Oil and Breather Filters

The lubricating system shall have two oil filters on the pump outlet side. One filter shall be for removing particles and the other for water removal. The filter for particles shall have a Beta rating of B6 greater than 75 at 60 psi differential tested in accordance with NFLPA T3.10.8.8 R1. The reducer manufacturer may propose an alternate Beta rating by submitting proof that B6 greater than 75 is unsuitable for the lubricant to be used. Each filter shall incorporate an oil-filled differential pressure gauge to indicate the pressure drop across the filter. The filter shall have an internal magnetic element. The water removal filter shall maintain a water content in the oil of no greater than 200 ppm. All filter assemblies shall be sized so the pressure drop across the clean filter is no greater than 4 psi. The particle filter shall be sized to avoid bypass at a startup oil temperature of 80 degrees F. Filters shall have a bypass setting of 45 to 60 psi. Element collapse rating shall not be less than 150 psi. The breather filter shall have a Beta rating of B6 greater than 75 and a desiccant chamber to remove water.

2.8.5 Heat Exchanger

The heat exchanger shall be an oil-to-air type with size based upon a maximum ambient temperature of 100 degrees F. Heat exchanger tubes and fins shall be copper or copper alloy. Working pressure shall exceed the oil pump working pressure. The heat exchanger shall withstand a test pressure of 150 percent of the design pressure held for a period of 4 hours during which time the heat exchanger shall be checked for leakage. Any leakage shall be cause for rejection. The oil-to-air heat exchanger system shall include a fan, motor, and controls for maintaining the specified oil temperature. The motor contactors and controls shall be contained in the control panel for the system. The system shall operate at 480 volt three phase, 60 Hz.

2.8.6 Piping and Tubing

Oil lines up to 2 inches o.d. shall be seamless steel tubing with 37 degree flare or flareless fittings. Where pipe sizes of 2 inches and over are required, steel pipe with welded fittings shall be used. All piping, tubing, and fittings shall conform to ASME B31.1. Vibration isolating tubing and piping supports shall be used. Oil tubing or ports shall be kept within the gear case where feasible. Dissimilar metals shall be electrically isolated to prevent corrosion.

2.8.7 Oil Heater

A thermostatically operated oil heater shall be installed to maintain the oil at a temperature of 80 degrees F. The heater shall be sized based on a minimum ambient temperature of 15 degrees F. The heater shall be capable of being shut off if the unit is to be out of service for an extended period. The heater shall have a watt density no greater than 6 W/inch squared. The heater shall operate at 480 volts and be powered and controlled from the system control panel.

2.8.8 Lubricating Oil

Lubricating oil shall be mineral oil or synthetic hydrocarbon as recommended in AGMA 6010-E or AGMA 6023-A for an ambient temperature range of 15 to 125 degrees F. The lubricant shall be suitable for the entire temperature range without change of lubricant. Lubricant additives shall be used as recommended by the reducer manufacturer. Lubricant shall also be suitable for use with the backstop. Lubricant used for the hydrodynamic thrust bearing shall be suitable for the bearing. Catalog data of the proposed lubricant shall be submitted for approval in accordance with paragraph SUBMITTALS.

2.9 INSTRUMENTATION AND CONTROLS

Instrumentation and control for the reducer shall be supplied and installed as a complete working package, coordinated with the pump and prime mover supplier. All electrical work shall conform to NFPA 70. Electrical enclosures shall be NEMA 250, Type 4. An electrical termination cabinet shall be provided. Available power is 460 V, 3 phase. This system shall be provided with single point of electrical supply to serve this complete system, including heaters, fans and oil pumps. The panel shall contain a main fusible disconnect switch with external operator, contactors, overload relays, control relays, and functional control devices. The panel shall be mounted on or adjacent to the angle gear housing approximately as indicated on the drawings. Mounting provisions for the panel shall be the responsibility of the gear manufacturer and shall be submitted for approval. Electrical work shall comply with SECTION 16415 ELECTRICAL WORK, INTERIOR. The speed reducer shall have the following devices as a minimum:

- a. High oil temperature switch in unit sump
 - (1) Alarm at 180 degrees F
 - (2) Shut down prime mover at 200 degrees F
 - (3) Lower settings may be used if recommended by the reducer manufacturer.
- b. Oil pressure gauge
 - (1) After oil pump
 - (2) Electric motor-driven prelubrication pump (if used)
 - (3) Gauges shall be oil or glycerin filled and shall have snubbers and isolation valves.
- c. Thermometer
 - (1) Sump
 - (2) Oil line after heat exchanger
 - (3) Backstop
- d. Oil Level Sight Gauge, with built in reflector
- e. Resistance Temperature Detector (RTD) 100 ohm platinum for Hydrodynamic Thrust Bearing, if used
 - (1) Alarm at 180 degrees F
 - (2) Shut down prime mover at 200 degrees F
 - (3) Lower settings may be used if recommended by the reducer and bearing manufacturers.
- f. Oil Pressure Switch
 - (1) Alarm at 80 percent of design pressure
 - (2) Shut down prime mover at 60 percent of design pressure
- g. Permissive and fault to shutdown the stormwater pumps.
 - (1) Provide dry pilot duty contacts which will shutdown the storm water pump on any operating condition above or recommended by the manufacturer which could damage the motor, angle gear or storm water pump.

- (2) Provide dry pilot duty contacts which will alarm and notify operating personnel to any operating condition which is outside of specified operating parameters as recommended by the manufacturer or within these specifications.

PART 3 EXECUTION

3.1 TESTS, INSPECTIONS, AND VERIFICATIONS

3.1.1 Shop Testing

In addition to or as part of the Contractor's normal shop testing procedure, the reducer shall be tested at rated speed, no load to check for potential problems which shall be eliminated prior to field testing. Gear contact patterns, sound level, lubrication and cooling, and all other operational characteristics shall be checked. The sound pressure level of the speed reducer and prime mover used in the shop test shall not exceed 90 dBA measured at a distance of 3 feet from the equipment. Sound shall be measured in accordance with AGMA 6025-C. The Contractor shall provide any preventative measures to control background noise. The Contractor shall notify the Contracting Officer 2 weeks prior to performing the shop test.

3.1.2 Installation

The Contractor shall install the speed reducer and shall ensure all features and systems are operational. The speed reducer shall be installed under the supervision of the reducer manufacturer's representative. The speed reducer shall be designed for ease of handling and installation. All necessary lifting devices, attachments, and special tools required for maintenance shall be provided by the Contractor.

3.1.3 Field Testing

The speed reducer shall be field tested at rated speed and load to demonstrate that reducer operation, lubrication, cooling, and instrumentation meet contract requirements. The duration of the testing shall be sufficient to develop verifiable gear contact patterns. Gear contact patterns shall be inspected and shown to the Contracting Officer. Gear contact patterns for helical gears shall be at least 70 percent of face width. Spiral bevel gears shall have a central toe contact pattern with contact of 50 percent of face width at full load. Gear contact patterns shall be photographed and included as part of the field test report. The report shall document all data collected for load and speed measurement, lubrication, oil temperature and flow, ambient temperature, gear contact patterns, and any other data required to show compliance with specifications.

End of Section

DIVISION 11 - EQUIPMENT

SECTION 11310

PUMPS: SEWAGE AND DEWATERING

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SECTION 11310

PUMPS: SEWAGE AND DEWATERING

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABEMA)

ABEMA Std 9 (1990) Load Ratings and Fatigue Life for Ball Bearings

ABEMA Std 11 (1990) Load Ratings and Fatigue Life for Roller Bearings

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 153 (1995) Zinc Coating (Hot-Dip) on Iron and Steel Hardware

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B40.1 (1991) Gauges - Pressure Indicating Dial Type - Elastic Element

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 1 (1993) Industrial Controls and Systems

NEMA MG 1 (1993; Rev 1; Rev 2) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (1999) National Electrical Code

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Sewage and Dewatering Pump System; GA.

Pump characteristic curves showing capacity in gpm, net positive suction head (NPSH), head, efficiency, and pumping horsepower from 0 gpm to 110 percent (100 percent for positive displacement

pumps) of design capacity. A complete list of equipment and material, including manufacturer's descriptive data and technical literature, performance charts and curves, catalog cuts, and installation instructions.

Spare Parts; FIO.

Spare parts data for each different item of material and equipment specified, after approval of the related submittals, and not later than 2 months prior to the date of beneficial occupancy. The data shall include a complete list of parts and supplies, with current unit prices and source of supply.

SD-04 Drawings

Sewage and Dewatering Pump System; FIO.

Drawings containing complete wiring and schematic diagrams and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Drawings shall show proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearances for maintenance and operation.

SD-06 Instructions

Sewage and Dewatering Pump System; FIO.

Diagrams, instructions, and other sheets proposed for posting.

SD-09 Reports

Field Testing and Adjusting Equipment; GA.

Performance test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Each test report shall indicate the final position of controls.

SD-19 Operation and Maintenance Manuals

Sewage and Dewatering Pump System; GA.

Six copies of operation and six copies of maintenance manuals for the equipment furnished. One complete set prior to performance testing and the remainder upon acceptance. Operation manuals shall detail the step-by-step procedures required for system startup, operation, and shutdown. Operation manuals shall include the manufacturer's name, model number, parts list, and brief description of all equipment and their basic operating features. Maintenance manuals shall list routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. Maintenance manuals shall include piping and equipment layout and simplified wiring and control diagrams of the system as installed. Manuals shall be approved prior to the field training course.

1.3 DELIVERY AND STORAGE

All equipment delivered and placed in storage shall be stored with protection from the weather, excessive humidity and excessive temperature variation; and dirt, dust, or other contaminants.

1.4 FIELD MEASUREMENTS

The Contractor shall become familiar with all details of the work, verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing the work.

PART 2 PRODUCTS

2.1 GENERAL MATERIAL AND EQUIPMENT REQUIREMENTS

Materials and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of such products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Equipment shall be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site. Pump casings shall be constructed of cast iron of uniform quality and free from blow holes, porosity, hard spots, shrinkage defects, cracks, and other injurious defects. Impellers shall be cast iron unless otherwise specified for rotors.

2.1.1 Nameplates

Each major item of equipment shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment.

2.1.2 Equipment Guards

Belts, pulleys, chains, gears, projecting setscrews, keys, and other rotating parts so located that any person may come in close proximity thereto shall be enclosed or guarded.

2.1.3 Special Tools

One set of special tools, calibration devices, and instruments required for operation, calibration, and maintenance of the equipment shall be provided.

2.1.4 Electric Motors

Motors shall conform to NEMA MG 1.

2.1.5 Motor Controls

Controls shall conform to NEMA ICS 1.

2.1.6 Bolts, Nuts, Anchors, and Washers

Bolts, nuts, anchors, and washers shall be steel; galvanized in accordance with ASTM A 153.

2.1.7 Pressure Gauges

Compound gauges shall be provided on the suction side of pumps and standard pressure gauges on the discharge side of pumps. Gauges shall comply with ASME B40.1. Gauge ranges shall be as appropriate for the particular installation.

2.2 DIAPHRAGM PUMP

Diaphragm pumps shall be of the self-priming, positive displacement type designed to pump sludge of various concentrations and levels of abrasiveness. The pump shall be designed such that operating the pump without liquid in the pump casing will not damage any portion of the pump.

2.2.1 Pump Characteristics

Pump number P-10 located in lower bay shall have the following operating characteristics:

- a. Pump Service: Sewage.
- b. Operator: air.
- c. Peak Capacity: 20 gpm flow.
- d. Total Dynamic Head: 40 feet.
- e. Suction and Discharge Check Valve Size: 2-inch.
- f. Diaphragm Material: Neoprene.
- i. Pump Control: Manual.

2.2.2 Casing

The pump body shall be designed to permit access to the casing interior without disassembling the suction and discharge piping.

2.2.3 Suction and Discharge Check Valves

The suction and discharge check valves shall be of the in-line flap check type. In-line flap check valves shall have an elastomeric seal on the disc to insure sealing and shall have a removable cover to permit inspection and cleaning of the valve interior without disassembling the adjacent piping.

2.2.4 Pulsation Dampers

An air chamber type pulsation damper shall be provided on the pump discharge.

2.2.5 Air-Operated Actuators

A complete air operated actuator shall be provided, with all accessories required for proper operation, including the following:

2.2.5.1 Muffler

An air exhaust muffler to ensure quiet operation.

2.2.5.2 Pressure Regulator

An air pressure regulator to maintain a constant air supply pressure to the pumping system. The air pressure regulator shall be field adjustable from 10 to 50 psi.

2.2.5.3 Strainer

An air supply strainer to remove particles larger than 100 microns from the air supply. The strainer shall have a removable cover to permit cleaning without dismantling adjacent piping.

2.3 DEWATERING SUBMERSIBLE CENTRIFUGAL PUMP

Submersible centrifugal pumps shall be centrifugal type pumps designed to pump solids up to 3 inches in diameter and shall be capable of withstanding submergence as required for the particular installation.

2.3.1 Pump Characteristics

Pump number P-8 located in the dewatering sump shall have the following operating characteristics:

- a. Pump Service: Treated Water.
- b. Design Operating Point: 500 gpm flow, 50 feet head.
- c. Impeller Type: Non-clog.
- d. Operating Speed: 1750 rpm.
- e. Motor Type: Submersible.
- f. Electrical Characteristics: 460 volts ac, 3 phase, 60 Hz.
- g. Size: Within rated load driving pump at specified rpm.
- h. Pump Control: Automatic with mercury float switches.

2.3.2 Pump Casing

The casing shall be capable of withstanding operating pressures 50 percent greater than the maximum operating pressures. The volute shall have smooth passages which provide unobstructed flow through the pump.

2.3.3 Mating Surfaces

Mating surfaces where watertight seal is required, including seal between discharge connection elbow and pump, shall be machined and fitted with nitrile rubber O-rings. Fitting shall be such that sealing is accomplished by metal-to-metal contact between mating surfaces, resulting in proper compression of the O-rings without the requirement of specific torque limits.

2.3.4 Coatings

Exterior surfaces of the casing in contact with sewage shall be protected by a sewage resistant coal tar epoxy coating. All exposed nuts and bolts shall be stainless steel.

2.3.5 Impeller

The impeller shall be of the single shrouded non-clogging design to minimize clogging of solids, fibrous materials, heavy sludge, or other materials found in sewage. The impeller shall be statically, dynamically, and hydraulically balanced within the operating range and to the first critical speed at 150 percent of the maximum operating speed. The impeller shall be securely keyed to the shaft with a locking arrangement whereby the impeller cannot be loosened by torque from either forward or reverse direction.

2.3.6 Wearing Rings

Wearing rings, when required, shall be renewable type and shall be provided on the impeller and casing and shall have wearing surfaces normal to the axis of rotation. Material for wear rings shall be standard of pump manufacturer. Wearing rings shall be designed for ease of maintenance and shall be adequately secured to prevent rotation.

2.3.7 Pump Shaft

The pump shaft shall be of high grade alloy steel and shall be of adequate size and strength to transmit the full driver horsepower with a liberal safety factor.

2.3.8 Seals

A tandem mechanical shaft seal system running in an oil bath shall be provided. Seals shall be of ceramic or tungsten carbide material with each interface held in contact by its own spring system.

2.3.9 Bearings

Pump bearings shall be ball or roller type designed to handle all thrust loads in either direction. Pumps depending only on hydraulic balance end thrust will not be acceptable. Bearings shall have an ABEMA L-10 life of 50,000 hours minimum, as specified in ABEMA 9 or ABEMA 11.

2.3.10 Motor

The pump motor shall have Class F insulation, NEMA B design, in accordance with NEMA MG 1, and shall be watertight. The motor shall be either oil filled, air filled with a water jacket, or air filled with cooling fins which encircle the stator housing.

2.3.11 Power Cable

The power cable shall comply with NFPA 70, Type SO, and shall be of standard construction for submersible pump applications. The power cable shall enter the pump through a heavy duty entry assembly provided with an internal grommet assembly to prevent leakage. The cable entry junction chamber and motor shall be separated by a stator lead sealing gland or terminal board which shall isolate the motor interior from foreign material gaining access through the pump top. Epoxies, silicones, or other secondary sealing systems are not acceptable.

2.3.12 Installation Systems

2.3.12.1 Rail Mounted Systems

Rail mounted installation systems shall consist of guide rails, a sliding bracket, and a discharge connection elbow. Guide rails shall be of the size and type standard with the manufacturer and shall not support any portion of the weight of the pump. The sliding guide bracket shall be an integral part of the pump unit. The discharge connection elbow shall be permanently installed in the wet well along with the discharge piping. The pump shall be automatically connected to the discharge connection elbow when lowered into place and shall be easily removed for inspection and service without entering the pump well.

2.3.12.2 Bolt Down Systems

The pump mount system shall include a base designed to support the weight of the pump. The base shall be capable of withstanding all stresses imposed upon it by vibration, shock, and direct and eccentric loads.

2.3.12.3 Lifting Chain

Lifting chain to raise and lower the pump through the limits indicated shall be provided. The chain shall be galvanized and shall be capable of supporting the pump.

2.4 SUMP PIT SUBMERSIBLE CENTRIFUGAL PUMPS

Submersible centrifugal pumps shall be centrifugal type pumps designed to pump solids up to 1/2 inch in diameter and shall be capable of withstanding submergence as required for the particular installation.

2.4.1 Pump Characteristics

Pump numbers P-9 located in the lower, middle bay sump pit shall have the following operating characteristics:

- a. Pump Service: Dewatering.
- b. Design Operating Point: 40 gpm flow, 15 feet head.
- c. Impeller Type: Non-clog.
- e. Operating Speed: 1550 rpm.
- f. Depth of Submergence: 2 feet.
- g. Motor Type: Submersible.
- h. Electrical Characteristics: 115 volts ac, 1 phase, 60 Hz.
- i. Size: Within rated load driving pump at specified rpm.
- j. Pump Control: Piggyback diaphragm pressure switch.

2.4.2 Pump Casing

The casing shall be capable of withstanding operating pressures 50 percent greater than the maximum operating pressures. The volute shall have smooth passages which provide unobstructed flow through the pump.

2.4.3 Mating Surfaces

Mating surfaces where watertight seal is required, including seal between discharge connection elbow and pump, shall be machined and fitted with nitrile rubber O-rings. Fitting shall be such that sealing is accomplished by metal-to-metal contact between mating surfaces, resulting in proper compression of the O-rings without the requirement of specific torque limits.

2.4.4 Impeller

The impeller shall be of the non-clogging design to minimize clogging of solids, fibrous materials, heavy sludge, or other materials found in sewage. The impeller shall be threaded onto the shaft.

2.4.5 Pump Shaft

The pump shaft shall be of high grade alloy steel or stainless steel and shall be of adequate size and strength to transmit the full driver horsepower with a liberal safety factor.

2.4.6 Seals

A tandem mechanical shaft seal system running in an oil bath shall be provided. Seals shall be of carbon, ceramic or tungsten carbide material with each interface held in contact by its own spring system.

2.4.7 Bearings

Pump bearings shall be ball or roller type designed to handle all thrust loads in either direction. Pumps depending only on hydraulic balance end thrust will not be acceptable.

2.4.8 Motor

The pump motor shall have Class F insulation, NEMA B design, in accordance with NEMA MG 1, and shall be watertight. The motor shall be either oil filled, air filled with a water jacket, or air filled with cooling fins which encircle the stator housing.

2.4.9 Power Cable

The power cable shall comply with NFPA 70, Type SO, and shall be of standard construction for submersible pump applications. The power cable shall enter the pump through a heavy duty entry assembly provided with an internal grommet assembly to prevent leakage. The cable entry junction chamber and motor shall be separated by a stator lead sealing gland or terminal board which shall isolate the motor interior from foreign material gaining access through the pump top. Epoxies, silicones, or other secondary sealing systems are not acceptable.

2.5 ELECTRICAL WORK

Electrical motor driven equipment specified shall be provided complete with motors, motor starters, and controls. Electric equipment and wiring shall be in accordance with Section 16415 ELECTRICAL WORK, INTERIOR. Electrical characteristics shall be as specified or indicated. Motor starters shall be provided complete with thermal overload protection and other appurtenances necessary for the motor control specified. Manual or automatic control and protective or signal devices required for the operation specified, and any control wiring required for controls and devices but not shown, shall be provided.

PART 3 EXECUTION

3.1 EQUIPMENT INSTALLATION

3.1.1 Pump Installation

Pumping equipment and appurtenances shall be installed in the position indicated and in accordance with the manufacturer's written instructions. All appurtenances required for a complete and operating pumping system shall be provided, including such items as piping, conduit, valves, wall sleeves, wall pipes, concrete foundations, anchors, grouting, pumps, drivers, power supply, seal water units, and controls.

3.1.2 Concrete

Concrete shall conform to Section 03301 CAST-IN-PLACE STRUCTURAL CONCRETE.

3.2 PAINTING

Pumps and motors shall be thoroughly cleaned, primed, and given two finish coats of paint at the factory in accordance with the recommendations of the manufacturer. Field painting required for ferrous surfaces not finished at the factory is specified in Section 09900 PAINTING, GENERAL.

3.3 FIELD TESTING AND ADJUSTING EQUIPMENT

3.3.1 Operational Test

Prior to acceptance, an operational test of all pumps, drivers, and control systems shall be performed to determine if the installed equipment meets the purpose and intent of the specifications. Tests shall demonstrate that the equipment is not electrically, mechanically, structurally, or otherwise defective; is in safe and satisfactory operating condition; and conforms with the specified operating characteristics. Prior to applying electrical power to any motor driven equipment, the drive train shall be rotated by hand to demonstrate free operation of all mechanical parts. Tests shall include checks for excessive vibration, leaks in all piping and seals, correct operation of control systems and equipment, proper alignment, excessive noise levels, and power consumption.

3.3.2 Retesting

If any deficiencies are revealed during any test, such deficiencies shall be corrected and the tests shall be reconducted.

3.4 MANUFACTURER'S SERVICES

Services of a manufacturer's representative who is experienced in the installation, adjustment, and operation of the equipment specified shall be provided. The representative shall supervise the installation, adjustment, and testing of the equipment.

3.5 POSTING FRAMED INSTRUCTIONS

Framed instructions containing wiring and control diagrams under glass or in laminated plastic shall be posted where directed. Condensed operating instructions, prepared in typed form, shall be framed as specified above and posted beside the diagrams. The framed instructions shall be posted before acceptance testing of the system.

3.6 FIELD TRAINING

A field training course shall be provided for designated operating and maintenance staff members. Training shall be provided for a total period of 2 hours of normal working time and shall start after the system is functionally complete but prior to final acceptance tests. Field training shall cover all of the items contained in the operating and maintenance manuals.

End of Section

DIVISION 11 - EQUIPMENT

SECTION 11330

MECHANICAL TRASH RAKE

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SECTION 11330

MECHANICAL TRASH RAKE

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABEMA)

ABEMA Std 9 (1990) Load Ratings and Fatigue Life for Ball Bearings

ABEMA Std 11 (1990) Load Ratings and Fatigue Life for Roller Bearings

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 36 (1996) Carbon Structural Steel

ASTM A 47 (1995) Ferritic Malleable Iron Castings

ASTM A 153 (1995) Zinc Coating (Hot-Dip) on Iron and Steel Hardware

UNDERWRITERS LABORATORIES (UL)

UL 98 (1994; R Oct 1995) Enclosed and Dead-Front Switches

1.2 GENERAL REQUIREMENTS

1.2.1 Standard Products

Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products. Equipment of the same type shall be products of the same manufacturer.

1.2.2 Nameplates

Each major item of equipment shall have manufacturer's name, address, and catalog or model number on a plate securely attached to item, or otherwise permanently marked.

1.2.3 Protection from Moving Parts

Moving parts of the equipment, such as drive chains and sprockets, shall be fully enclosed in removable guards. Housing shall ensure ready access to any part of equipment for repairs, replacements, or cleaning. Joint between the housing and the concrete foundation shall be made leakproof.

1.2.4 Verification of Dimensions

The Contractor shall become familiar with all details of the work, verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing the work.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Spare Parts; GA.

Not later than 2 months prior to the date of beneficial occupancy, the Contractor shall furnish spare parts data for each different item of materials and equipment specified. The data shall include a complete list of parts and supplies, with current unit prices and source of supply, and a list of the parts recommended by the manufacturer to be replaced after 1 and 3 years of service.

SD-04 Drawings

Mechanical Trash Rake; GA.

Detail drawings shall consist of a complete list of equipment and materials, including manufacturer's descriptive and technical literature, catalog cuts; and installation instructions.

SD-06 Instructions

Framed Instructions; FIO.

Framed instructions under glass or in laminated plastic, including wiring and control diagrams showing the complete layout of the entire system, shall be posted where directed. Condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system shall be prepared in typed form, framed as specified above for the wiring and control diagrams and posted beside the diagrams. Proposed diagrams, instructions, and other sheets shall be submitted prior to posting. The framed instructions shall be posted before acceptance testing of the systems.

SD-19 Operation and Maintenance Manuals

Mechanical Trash Rake; GA.

Six complete copies of operation manual outlining the step-by-step procedures required for system start-up, operation and shutdown. The manual shall include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. Six complete copies of maintenance manual listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. The manual shall include simplified diagrams for the system as installed.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

Materials and equipment shall conform to respective publications and requirements as follows:

2.1.1 Bearings

ABEMA Std 9 and ABEMA Std 11.

2.1.2 Iron, Steel, and Miscellaneous Metal

2.1.2.1 Miscellaneous Metal

Bolts, nuts, anchors, washers, and other types of supports necessary for the installation of equipment shall conform to ASTM A 153.

2.1.2.2 Malleable Iron

ASTM A 47, grade No. 32510, minimum.

2.1.2.3 Structural Steel

With the exception of totally sealed hollow structural sections, all structural steel shall be new material, shall conform to ASTM A 36, and shall have a minimum 1/4" section thickness.

All welding shall conform to the latest AWS Standards and shall employ certified welders. All welding shall be a minimum of 3/16" fillets, and shall completely seal each joint. No skip welding will be allowed.

All bolted structural connections shall be gusseted with minimum 3/8" thick steel plate. Each structural connection shall have a minimum of two 3/4" diameter bolts. Secondary connections shall have a minimum of two 5/8" diameter bolts.

2.1.3 Switches, Enclosed

UL 98.

2.1.4 Coatings

All steel fabricated components of the mechanically cleaned trash rakes shall be sandblasted and finish painted in the field prior to assembly. Coatings shall be as specified in the Protective Coatings section of these specifications.

2.1.5 Anchorage and Fasteners

All structural fasteners defined as erection bolts 5/8" in diameter and larger shall be of AISI Type 304 stainless steel.

All cast-in-place equipment anchorage, including nuts and washers shall be of AISI Type 304 stainless steel. The minimum size of any cast-in-place anchor shall be 3/4" in diameter.

All installed anchors shall be drop-in style (hole size equals bolts size), and shall conform to Federal Specifications GSA FF-S-325, Group II, Type 4, Class 1. Anchor bolts to be Type 303 and clips, nuts and washers to be Type 304 stainless steel. The minimum size of any drop-in anchor shall be 5/8" diameter.

2.1.6 Equipment

2.1.6.1 Head Frame Assembly

The catenary chain shall be driven and supported by a fabricated frame assembly consisting of a steel frame, head shaft, idler shaft, sprockets, return guides, drive components and rake wiper.

The rake drive shaft and idler shaft shall be manufactured from minimum 8" diameter schedule 40 steel pipe torque tube bushed and fitted with 3-15/16" diameter cold rolled C1020 solid steel stub shafts at each end. The drive stub shafts will be key slotted for a 1" square key and the slots shall radially align with each other. One of the idler stub shafts will be key slotted for a 1" square key and the other will be polished to accept a bronze bushed idler sprocket and positioning set collar. Each stub shaft shall be supported by a double row, self-aligning roller bearing pillow blocks with grease seals and four hole base to carry the drive and idler shafts. Provision to lock the inner race to the shaft will be required.

The rake chain sprockets shall be high grade alloy cast iron sprockets with teeth and rims chilled to a minimum Brinell hardness of 375 for depth of not less than 3/16". Each sprocket will have 8 teeth and a pitch diameter of 23.5". One sprocket will be bored to 3-15/16" and fitted with a 1" square key. The other sprocket will be sleeved with a bronze bore liner of 3-15/16" internal diameter. Provision for lubrication of bronze bushing is incorporated into the sprocket on the shafts.

The rake chain shall be guided as needed by horizontal and vertical chains guides. Each is fabricated from C6 x 10.5 lb. structural channel members and supported by W8 x 24 lb. wide flange beams anchored to the concrete structure walls with minimum 3/4" diameter anchor bolts. The vertical chain guides shall be slotted to allow for 4" horizontal adjustment.

2.1.6.2 Chain

The screening rakes shall be spaced at approximately 12'-0" intervals and shall attach to two matched strands of Style T conveyor chain with 2.0" high side bars, 0.75" diameter pins and 9.0" pitch. The chain shall have a minimum working load rating of 7200 pounds. Rake chain side bars will be zinc plated and the pins will be drilled and fitted with high pressure lubrication fittings. Corrosion resistant cotter pins will be used for chain assembly.

2.1.6.3 Rakes

Fabricated steel carriers are to be provided at the intervals indicated. The rakes shall be constructed from W8 x 24 lb. wide flange beams. The beams will have a 6" x 4" x 1/2" angle rake member with saw tooth notches cut on 4" centers and welded to the upstream side of the channel. The rake will have 1/2" steel plate bumpers welded to each end and will be counterbalanced with a full length steel bar to preclude erratic chain action.

2.1.6.4 Drive

The head shaft shall be driven by a sprocket and roller chain connected to a drive sprocket mounted to the output shaft of a commercially available double reduction helical gear reducer.

The drive motor shall be rated for a minimum of 1.5 HP, 1750 rpm and shall be TEFC with a 1.15 SF, NEMA Design B with Class F insulation. Power supply shall be 3 phase, 60 cycle, 460 volt. The motor hardware shall be of a standard "Severe Duty" classification for hostile environments. The motor shall be flange mounted to the reducer.

The gear reducer shall be double reduction helical gear unit, totally enclosed in a cast iron housing, AGMA class II rating. The reducer is driven with the motor through a torque limiting coupling designed to absorb impact energy of up to 30% of motor reducer rating and to slip at a predetermined overload. The reducer shall be mounted on a slide base for chain slack adjustment and the coupling shall be equipped with a motor shut-off control which shall open the motor circuit when the driven shaft speed falls below normal. The overload shut-off control will be factory calibrated for shutdown at 125% of full load rating but adjustable to 200%.

The drive chain shall be a minimum 3.075" pitch class MXS offset steel roller chain. The drive sprocket shall be a chill rim design, at least 10 teeth, and shall be keyed and locked to the drive unit output shaft. The driven sprocket to drive sprocket tooth ratio shall not exceed 4:1. The driven sprocket shall be a chill rim design, fitted with a special shear pin hub assembly designed to prevent damage to the bar screen due to sudden overloads or jamming. The drive chain shall be tensioned by mounting the drive unit on a sliding base held in position by heavy jack bolts.

The entire drive chain assembly shall be totally enclosed in a steel, split chain casing. The casing shall be fabricated of 12 gauge steel with easily removable top half and will be oil and dust tight with bottom drain cock, filler cap and oil level gauge.

2.1.6.5 Portable Pneumatic Grease Pump Kit

Screen manufacturer shall provide a 12 pound drum of recommended grease for bearings, a positive displacement, self-priming grease pump with 25 feet of hose and grease gun for mounting on the drum of grease for operation on 80 - 100 psi air and a two wheel hand truck sized and designed for transporting a 120 pound grease drum with pneumatic grease pump in place.

2.1.6.6 Controls

Trash Rake Control Panel: A local control panel mounted on a steel support stand near each trash rake shall be provided and include a NEMA size 1 reversing starter, 0.5 KVA CPT and start/stop pushbutton, run light and overload light, indication and alarm contacts and accessories for all required and specified features, all enclosed in a weatherproof NEMA 4, stainless steel, corrosion resistant enclosure. The enclosure shall be mounted on a heavy steel frame near the drive unit as shown on the plans. Push buttons and exterior controls shall be oil tight with weatherproof boots.

2.1.6.7 Protective Coatings

Scope: All fabricated steel for the trash rakes shall be painted by the Contractor before shipping to the jobsite. The paint system for the all the trash rakes components shall be as specified in Section 09940 PAINTING: HYDRAULIC STRUCTURES.

2.2 ELECTRICAL WORK

Electrical equipment and wiring shall be in accordance with Section 16415 ELECTRICAL WORK, INTERIOR. Electrical characteristics shall be as indicated.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Manufacturer's Service Representative

The trash rakes shall be furnished complete by the manufacturer and assembled, erected, and installed by the Contractor as directed by the manufacturer in his working drawings and written instructions. The installation, alignment, and testing shall be checked and approved by a factory representative before acceptance.

The Contractor shall include in his bid the services of a factory trained representative for a period of two (2) days and two (2) trips. The manufacturer's representative shall inspect the completed installation, and assist the Contractor in aligning, start-up and testing. The representative shall also instruct plant personnel in the operation and maintenance of equipment.

A written report shall be furnished by the equipment manufacturer and shall describe the representative's observations. The report shall describe in detail any deficiencies noted. All such deficiencies, whether by the manufacturer or Contractor, shall be corrected at no expense to the Owner.

Prior to final approval, the manufacturer shall submit a letter certifying that the installation meets all requirements of the manufacturer.

3.1.2 Lubrication

Lubricants of the type recommended by the equipment manufacturer shall be applied by the Contractor. The Contractor shall certify that the drive and bearings have received the proper amount of recommended lubricant.

3.1.3 Anchorage

The equipment manufacturer shall furnish all required anchor bolts with leveling nuts, washers, and tie-down nuts. The anchorage shall be placed by the Contractor in exact accordance with the manufacturer's certified dimension prints and as directed by the manufacturer. The Contractor shall furnish all templates needed to accurately set the anchor bolts to the dimensions and projections specified.

End of Section

DIVISION 12 - FURNISHINGS

SECTION 12390

CABINETS AND COUNTERTOPS

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End of Section Table of Contents

SECTION 12390

CABINETS AND COUNTERTOPS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

BUILDERS HARDWARE MANUFACTURERS ASSOCIATION (BHMA)

BHMA A156.9 (1994) Cabinet Hardware

KITCHEN CABINET MANUFACTURERS ASSOCIATION (KCMA)

KCMA A161.1 (1995) Recommended Performance & Construction Standards for Kitchen and Vanity Cabinets

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA LD 3 (1995) High-Pressure Decorative Laminates

1.2 DESIGN

Cabinets shall be wood, factory-fabricated and finished in the manufacturer's standard sizes and finishes of the type, design, and configuration indicated. Cabinets shall be constructed as specified and shall meet the requirements of KCMA A161.1. Wall and base cabinet assemblies shall consist of individual units joined into continuous sections. Fastenings shall be accomplished to permit removal and replacement of individual units without affecting the remainder of the installation. Counters shall be provided with watertight sink rim when indicated. Drawers shall be removable and shall be equipped with position stops to avoid accidental complete withdrawals. Shelves shall be fixed or adjustable as indicated.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Cabinets and Countertops; GA.

Manufacturer's printed data, catalog cuts, and installation instructions.

SD-04 Drawings

Cabinets and Countertops; GA.

Drawings showing each type of cabinet and related item, and clearly indicating the complete plan and elevations of the cabinets and accessories and pertinent details of construction, fabrication, and attachments.

SD-09 Reports

Cabinets and Countertops; FIO.

Test reports shall certify that all cabinets comply with the requirements of KCMA A161.1. Tests shall be conducted by independent laboratories approved by KCMA. KCMA certification seals affixed to the cabinets will be accepted in lieu of certified test reports.

SD-14 Samples

Cabinets and Countertops; GA.

Samples shall be of sufficient size to show color pattern and method of assembly.

- a. Melamine plastic color samples shall be approximately 2 x 3 inches size.
- b. Stain/color samples shall be approximately 2 x 3 inches size.

1.4 DELIVERY AND STORAGE

Cabinets shall be delivered to the jobsite wrapped in a protective covering. Cabinets shall be stored in an adequately ventilated, dry location that is free of dust, water, or other contaminants and in a manner to permit access for inspection and handling. Cabinets shall be handled carefully to prevent damage to the surfaces. Damaged items that cannot be restored to like-new condition shall be replaced.

PART 2 PRODUCTS

2.1 CABINETS

Wall and base cabinets shall be of the same construction and same outside appearance. Door design shall be solid flush face. Shelves shall be fixed or fully adjustable as indicated. Adjustable shelves shall be capable of adjusting on approximately 1-1/4 inch increments. Shelves shall be supported by self-locking clips or wood dowels. Dowels shall be approximately 5/16 inch in diameter by 1-9/16 inches long. Dowels shall be inserted into borings for the shelf adjustments. Shelves shall be minimum 1/2 inch thick plywood or minimum 1/2 inch thick 45 pound density particle board. Drawer fronts shall be 5/8 inch thick, 5 ply hardwood plywood.

2.1.1 Frame Type Cabinets

The cabinets shall be constructed with frame fronts and solid ends, or frame construction throughout. Frame members shall be 3/4 inch thick by 1-1/2 inch wide; kiln-dried hardwood, glued together, and shall be either mortised and tenoned, dovetailed or doweled, nailed, stapled or screwed. Top and bottom corners shall be braced with either hardwood blocks that are glued together with water resistant

glue and nailed in place, or metal or plastic corner braces. Backs of wall cabinets shall be 1/8 inch thick plywood or tempered hardboard. Backs of base and tall cabinets shall be 3/8 inch thick hardwood plywood or 3/8 inch thick, 45 pound density particle board. Bottoms of cabinets shall be minimum 3/8 inch thick plywood sound grade and shall be braced with wood members glued in place. Cabinet ends shall be 5/8 inch thick hardwood plywood.

2.2 COUNTERTOPS AND BACKSPLASH

2.2.1 General

Countertop and backsplash shall be constructed of 3/4 inch thick plywood or 3/4 inch thick, 45 pound density particle board core and shall be post formed cove type or fully formed type. Cove type shall be a single unit with self-edging and plastic laminate coved at the juncture of the countertop and backsplash. Fully formed type or square edge shall be a unit with shaped edges using wood nose molding at counter edge and shall include a separate backsplash. Backsplash shall be not less than 3-1/2 inches high. Edging and trim shall consist of plastic laminate cut and fitted to all exposed edges. End splashes constructed of 3/4 inch plywood or 3/4 inch thick, 45 pound density particle board core shall be supplied.

2.2.2 Sink Rims

Sink rims shall be of the corrosion resistant steel clamping type, sized to the sink, and a standard product of a manufacturer regularly producing this type of equipment.

2.3 FINISH

2.3.1 Cabinet Finish

Cabinets shall be provided with a factory-applied durable finish of a type standard with the manufacturer. Exposed exterior surfaces shall be paint-finished wood doors, drawer fronts, cabinet fronts, and exposed cabinet sides fabricated of hardwood or grade C hardwood veneer. Colors shall be selected from manufacturer's standard.

2.3.2 Melamine Laminates on Countertops

Continuous sheets of longest lengths practicable shall be provided. Joints in surface sheeting shall be tight and flush and held to a practicable minimum. When the countertop and backsplash are two separate units, GP50 plastic laminate shall be used. When the countertop and backsplash are one unit, PF42 plastic laminate shall be used. Plastic laminate shall conform to the requirements of NEMA LD 3 and plastic laminate adhesive shall be contact type applied to both surfaces. For fully formed and cove type countertops, the post-forming plastic laminate shall not be bent to a radius smaller than the limit recommended by the plastic manufacturer. Design, color, and finish shall be selected from manufacturer's standard.

2.3.3 Backer Sheets

Backer Sheets of high pressure plastic laminate, shall conform to NEMA LD 3, Grade BK20 and shall be applied to the underside of all core material. Design, color, and finish shall be selected from manufacturer's standard.

2.4 HARDWARE

Hardware shall conform to BHMA A156.9, shall be suitable for kitchen cabinet use, and shall include all miscellaneous hardware for a complete installation. Door hinges shall be self-closing type. Drawer runners shall have nylon rollers standard with the manufacturer. Hardware and fastenings for doors and drawers with particle board cores shall be of the through-bolt type. The types and finishes of hardware shall be brushed aluminum.

PART 3 EXECUTION

3.1 INSTALLATION

Cabinets shall be installed level, plumb, and true to line, and shall be attached to the walls or floors with suitable devices to securely anchor each unit. Countertops, accessories, and hardware shall be installed as indicated. Installation shall be in accordance with the manufacturer's approved printed instructions. The inner edge of sink cut-outs in laminated plastic tops shall be painted with a coat of semigloss enamel paint and sink flanges shall be set in a bed of sealant. Closer and filler strips and finish moldings shall be provided as required. Prior to final acceptance, doors shall be aligned, hardware adjusted, and cabinets left in a clean neat condition.

End of Section

Invitation No. W912EQ-04-B-0020

DIVISION 13

(NOT USED)

DIVISION 14 - CONVEYING SYSTEMS

SECTION 14630

OVERHEAD ELECTRIC CRANES

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SECTION 14630

OVERHEAD ELECTRIC CRANES

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN GEAR MANUFACTURERS ASSOCIATION (AGMA)

AGMA 2000-A	(1988; Errata Jan 1989) Gear Classification and Inspection Handbook
AGMA 2001-C	(1995) Fundamental Rating Factors and Calculation Methods for Involute Spur and Helical Gear Teeth
AGMA 6010-F	(1997; Errata Nov 91) Standard for Spur, Helical, Herringbone and Bevel Enclosed Drives
AGMA 6019-E	(1989) Gearmotors Using Spur, Helical, Herringbone, Straight Bevel, or Spiral Bevel Gears

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 159	(1993; R 1993) Automotive Gray Iron Castings
ASTM A 325	(1997) Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A 668	(1996)e1 Steel Forgings, Carbon and Alloy, for General Industrial Use
ASTM B 438	(1995a) Sintered Bronze Bearings (Oil-Impregnated)
ASTM B 439	(1995) Iron-Base Sintered Bearings (Oil-Impregnated)
ASTM B 612	(1996) Iron Bronze Sintered Bearings (Oil-Impregnated)
ASTM E 125	63(1997) Magnetic Particle Indications on Ferrous Castings

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B30.2	(1996; B30.2a; B30.2b; B30.2c; B30.2d) Overhead and Gantry Cranes (Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist)
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ASME B30.16 (1999; B30.16a; B30.16b; B30.16c) Overhead Hoist (Underhung)

ASME B30.17 (1998; Errata; Sep 1993; B30.17a; B30.17b; B30.17c) Overhead and Gantry Cranes (Top Running Bridge, Single Girder, Underhung Hoist)

AMERICAN WELDING SOCIETY (AWS)

AWS D14.1 (1997) Welding of Industrial and Mill Cranes and Other Material Handling Equipment

MATERIAL HANDLING INSTITUTE (MHI)

MHI CMAA 70 (1994) Electric Overhead Traveling Cranes

MHI CMAA 74 (1994) Top Running & Under Running Single Girder Electric Overhead Traveling Cranes Utilizing Under Running Trolley Hoist

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 2 (1993) Industrial Control and Systems, Controllers, Contactors, and Overload Relays Rated Not More Than 2,000 Volts AC or 750 Volts DC

NEMA ICS 6 (1996) Industrial Control and Systems, Enclosures

NEMA MG 1 (1993; Rev 1; Rev 2) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (1999) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 489 (1996) Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures

UL 1449 (1985; Errata Apr 1986) Transient Voltage Surge Suppressors

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Overhead Crane System; GA.

A complete list of equipment and materials, including manufacturer's descriptive data and technical literature, performance charts and curves, catalog cuts, and installation instructions.

Spare Parts; GA.

Spare parts data for each different item of material and equipment specified, after approval of the detail drawings and not later than 3 months prior to the date of beneficial occupancy. The data shall include a complete list of parts and supplies, with current unit prices and source of supply.

SD-04 Drawings

Overhead Crane System; GA.

Detail drawings containing complete wiring and schematic diagrams. Diagrams shall indicate each numbered wire, where wire initiates, where wire terminates, and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Drawings shall show layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearances for maintenance and operation.

SD-06 Instructions

Framed Instructions FIO.

Diagrams, instructions and safety requirements.

SD-09 Reports

Acceptance Testing; FIO.

Test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. The report shall include the information as required by paragraph ACCEPTANCE TESTING.

SD-18 Records

Hooks; FIO.

Hook material and any heat treatment performed, stamped on the hook shank or documented in certification papers furnished with the hooks. Crane test data recorded on appropriate test record forms suitable for retention for the life of the crane.

SD-19 Operation and Maintenance Manuals

Overhead Crane System; GA.

Six copies of operation and six copies of maintenance manuals for the equipment furnished. One complete set prior to performance testing and the remainder upon acceptance. Operation manuals shall detail the step-by-step procedures required for system startup, operation and shutdown. Operation manuals shall include the manufacturer's name, model number, parts list, and brief description of all equipment and basic operating features. Maintenance manuals shall list routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. Maintenance manuals shall include piping and equipment layout and simplified wiring and control diagrams of the system as installed. Operation and maintenance manuals shall be approved prior to the field training course.

1.3 QUALIFICATION

Electric overhead cranes shall be designed and manufactured by a company with a minimum of 10 years of specialized experience in designing and manufacturing the type of overhead crane required to meet requirements of the Contract Documents.

1.4 TESTING AND INSPECTIONS

1.4.1 Pre-Delivery Inspections

Contractor shall be responsible for performance of quality control inspections, testing and documentation of steel castings, hook assembly and safety as follows.

1.4.1.1 Inspection of Steel Castings

Load-carrying steel castings shall be visually inspected and tested using the magnetic-particle inspection method. Allowable degree of discontinuities shall be referenced to ASTM E 125, and shall be related to service loads and stresses, critical configuration, location and type. Methods of repairing the discontinuities shall be subject to review by the Contracting Officer.

1.4.1.2 Inspection of Hook Assembly

Hook and nut shall be inspected by a magnetic-particle type inspection or X-rayed prior to delivery. Documentation of hook inspection shall be furnished to Contracting Officer at the field operational testing. As part of the acceptance standard, linear indications will not be allowed. Welding repairs of hook will not be permitted. A hook showing linear indications, damage or deformation will not be accepted, and shall be replaced.

1.5 DESIGN CRITERIA

Cranes shall operate in the given spaces and shall match the runway dimensions and rails indicated. Hook coverage, hook vertical travel, clear hook height, lifting capacity, and load test weight shall not be less than that indicated.

1.5.1 General

The hoisting equipment shall include the following:

Number of cranes; 1, located in building name; New Madrid Pumping Station, with a number of tons; 25 ton, electric overhead traveling crane. Classification

Crane shall be designed and constructed to MHI CMAA 70 Class A, standby service requirements for operation in non-hazardous environment with hoist in accordance with ASME HST-1M.

1.5.2 Rated Capacity and Speeds

Rated capacity of crane shall be 25 tons. Lower load block or assembly of hook, swivel bearing sheaves, pins and frame suspended by the hoisting ropes shall not be considered part of the rated capacity. Rated speeds (in feet per minute) for the hoist, bridge and trolley at the rated load shall be as follows:

Description	Minimum	Maximum
Main Hoist	1.6	16
Trolley	20	80
Bridge	20	80

1.6 DELIVERY AND STORAGE

Equipment delivered and placed in storage shall be stored with protection from the weather, humidity and temperature variations, dirt and dust, and other contaminants.

1.7 FIELD MEASUREMENTS

Before performing any work, Contractor shall become familiar with all details of the work, verify all dimensions in the field, and submit a letter describing the results of this verification including discrepancies to the Contracting Officer and crane manufacture.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 General

Materials and equipment shall be standard products of manufacturers regularly engaged in the fabrication of complete and totally functional cranes including necessary ancillary equipment.

2.1.2 Nameplates

Nameplates shall be secured to each major component of equipment with the manufacturer's name, address, type or style, model or catalog number, and serial number. Two bridge identification plates shall be provided, one for each side of bridge. Identified plates shall be noncorrosive metal with letters which are easily read from the floor, showing a separate number such as BC-1, BC-2, for each bridge crane.

2.1.3 Use of Asbestos Products

Materials and products required for designing and manufacturing cranes shall not contain asbestos.

2.1.4 Capacity Plates

Two capacity plates indicating the crane capacity in tons are required, one secured to each side of bridge. Each capacity plate shall be fabricated of a steel backing plate and exterior quality/fade-resistant stick-on labels with letters large enough to be easily read from the floor. Capacity plates shall be placed in a location visible to pendant operator's position after the crane has been installed.

2.1.5 Safety Warnings

Readable warning labels shall be affixed to each lift block or control pendant in a readable position in accordance with ASME B30.16, ASME B30.2 and ASME B30.17. The word "WARNING" or other legend shall be designed to bring the label to the attention of the operator. Warning labels shall be durable type and display the following information concerning safe-operating procedures: Cautionary language against lifting more than the rated load; operating the hoist when the hook is not centered under the hoist; operating hoist with twisted, kinked or damaged rope; operating damaged or malfunctioning hoist; operating a rope hoist with a rope that is not properly seated in its hoist drum groove; lifting people; lifting loads over people; and removing or obscuring the warning label.

2.1.5.1 Directional Arrows

To avoid operation of crane in the wrong direction, the words "FORWARD" and "REVERSE" and accompanying directional arrows shall be affixed in a location on the trolley and bridge which are visible and readable to the operator from pendant station. The words "FORWARD" and "REVERSE" shall agree with the markings on control pendant. Directional arrows shall not be indicated on control pendant.

2.2 STRUCTURAL MATERIALS

2.2.1 Bolts, Nuts and Washers

High-strength bolted connections shall utilize SAE Grade 5 bolts with corresponding lockwashers, nuts, etc., conforming to requirements of AISC-S329 bolts. Bolts, nuts and washers shall conform to ASTM A 325 bolts. Galvanized bolts are not acceptable.

2.2.2 Bridge Rails or Bars

Trolley runway rails, crane girders and other sections shall be straight and true. When loaded with motor driven cranes the deflection of rails shall not exceed 1/800 of the span. The deflection shall be calculated with the worst case of two loaded bridge cranes located adjacent each other. Rail joints shall be flush and true without misalignment of running tread and shall be designed to minimize vibration. The gap between adjacent rail ends and the vertical misalignment of running treads shall not exceed 0.0625 inch. The bridge rail shall be leveled to a plus-or-minus 1/8 inch at all rail support joints. Bridge rail joints shall be bolted using standard joint bars. Rail joints shall be staggered. A positive stop shall be provided at bridge rail ends to prevent creep.

2.2.3 End Ties and Bridge Girder End Connections

Welded steel box sections shall be used for end ties, full depth diaphragms shall be provided at girder connections and jacking points. Horizontal gusset plates shall be provided at the elevation of top and

bottom end tie flanges for connection to girder ends. End connections shall be made with high-strength bolts. Body-bond bolts fitted in drilled and reamed holes shall be used to maintain the crane square.

2.2.4 Bridge End Trucks

End trucks shall be the rotating or fixed axle type fabricated of structural tubes or from structural steel to provide a rigid box section structure. Jacking pads shall be provided for removal of wheel assemblies.

2.2.5 Trolley Frame

Trolley frame shall consist of two structural steel side frames or trucks welded together with one or more structural steel load girts to form a one-piece unit. Pads shall be provided for the use of jacks or wedges when changing truck wheels. All trolley yokes and load bars shall be of drop forged, cast or rolled steel.

2.2.6 Stops and Bumpers

Crane runways and bridge girders shall be fitted with structural steel end stops. Bridge end trucks and trolley frames shall be fitted with shock-absorbing, spring or hydraulic type bumpers capable of decelerating and stopping the bridge and/or trolley within the limits stated by OSHA and MHI CMAA. Trolley end stops shall be of sufficient strength to withstand the impact of a fully loaded trolley moving at 50 percent of maximum rated travel speed. Bridge bumper stops shall be provided as shown on drawings.

2.2.7 Footwalks

A full-length structural platform is required on the bridge. The platform shall be checkered steel flooring, double member handrail and a suitable toe-guard, with 30 inch clearance in front of control equipment. Minimum 15 inch clearance is required in front of bridge machinery. Short and full rear platforms and cross-over walks are optional.

2.2.8 Runway Rails

The runway rail size shall be 60 lbs. unless otherwise recommended by crane manufacturer.

2.3 MECHANICAL EQUIPMENT

2.3.1 Drives

2.3.1.1 Bridge Drives

Bridge drives shall be either the A-1 or A-4 drive arrangement as specified in MHI CMAA 70 or MHI CMAA 74. Bridge drive shall consist of a single electric motor mechanically connected through gear reduction and drive shafts to the drive wheels or separate drive motors at each end of bridge. Acceleration and deceleration shall meet the requirements specified in this section. Gears shall conform to applicable AGMA standards. Gear reducers shall be oil tight and fully enclosed with pressure or splash type lubrication. Bridge-travel limit-switches shall be furnished.

2.3.1.2 Trolley Drives

Trolley shall be complete with a drive arrangement with a minimum of two wheels driven by an integral electric motor. Drive mechanism shall run in totally enclosed oil bath. Acceleration and deceleration controls shall meet requirements specified in this section.

2.3.2 Load Blocks

2.3.2.1 Main Hoist Load Blocks

Load blocks shall be of welded steel construction. Load blocks shall be provided with hot-rolled or forged steel fixed crosshead separate from the sheave pin with swivel mounting for forged steel hook. Each lubrication fitting for sheave pins shall be an independent type recessed within the sheave pin or adequately guarded to prevent damage. The pitch diameter of the sheaves shall be not less than 16 times the rope diameter. Sheaves shall be supported by roller type bearings on steel sheave pins. Provisions for external lubrication shall be provided to allow pressure relief and purging of old grease. Sheave blocks shall be constructed to provide maximum personnel safety and to prevent the hoist rope from leaving the sheaves under normal operating condition.

2.3.2.2 Hook Assembly

Hooks shall be single barbed and shall be made of forged steel complying with ASTM A 668. Hook dimensions shall be as shown. Hooks shall be fitted with safety latches designed to preclude inadvertent displacement of slings from the hook saddle. Painting or welding shall not be performed on the hook. Hook nut shall be secured with a removable type set screw or other similar fastener, but shall not be welded. Hooks shall be designed and commercially rated with safety factors in accordance with MHI CMAA. The hook shall be free to rotate through 360 degrees when supporting the rated load.

2.3.3 Hoisting Ropes

Hoisting ropes shall be regular lay, preformed, uncoated, improved plow steel, 6 by 37 construction, with independent wire rope core. Ropes shall be suited to meet the service requirements. Rope socketing or U-bolt clip connections shall be made in accordance with clip or rope manufacturer's recommendation, and shall be equal to or greater than the rope strength. Hoisting ropes shall be the rated capacity load plus the load block weight divided by the number of rope parts, and shall not exceed 20 percent of the certified breaking strength of rope. Hoisting ropes shall be secured to hoist drum so that no less than two wraps of rope remain at each anchorage of hoist drum at the extreme low position (limit switch stop).

2.3.4 Sheaves

Sheaves shall be of cast, forged, rolled, or welded structural steel. Sheave grooves shall be accurately machined, smoothly finished and free of surface defects.

2.3.5 Hoist Drums

Hoist drums shall be of welded rolled structural steel, cast steel, or seamless steel pipe. Diameter of drum shall be not less than 24 times the diameter of hoist cable. Drums shall be machined and provided with right-hand and left-hand grooves to take the full run of cable for the required lift without overlapping, plus a minimum of two full wraps of cable when load is on floor. At least one groove

shall remain unused when hook is at the highest position. Drum grooves shall be cut from solid stock and have sufficient depth for size of cable required. Drum flanges shall be guarded so that the cable cannot wedge between drum flange and hoist frame.

2.3.6 Gearing

Gearing shall be of the enclosed gear reducers type. Gears and pinions shall be spur, helical, or herringbone type only, and shall be forged, cast or rolled steel; open-type gearing is not acceptable. Gears and pinions shall have adequate strength and durability for the crane service class and shall be manufactured to AGMA 2001-B Quality Class 6 or better precision per AGMA 2000-A.

2.3.6.1 Gear Reducers

Gear reducers shall be standard items of manufacturers regularly engaged in the design and manufacture of gear reducers for Class D and G cranes or shall be integral components of standard hoists or hoist/trolley units of manufacturers regularly engaged in the design and manufacture of hoists or hoist/trolley units for Class A, B or C cranes. Gear reducers shall be designed, manufactured and rated in accordance with AGMA 6010-E, AGMA 6019-E (for trolley drives only), as applicable. Except for final reduction, the gear reduction units shall be fully enclosed in oil-tight housing. Gearing shall be designed to AGMA standards and shall operate in an oil bath. Operation shall be smooth and quiet.

2.3.7 Brakes

Brakes shall be of the shoe or disc type with thermal capacity suitable for class and service specified in this section. Shoe and disc brakes shall be spring-set and electrically-released by a continuously rated direct acting magnet. Brakes shall be self-aligning and provide for easy adjustment for torque setting and lining wear. Brake lining material shall be asbestos free. Brake wheels shall be cast iron conforming to ASTM A 159 or shall be the manufacturer's standard high-strength ductile cast-iron, provided that the material exhibits wear characteristics in the form of powdered wear particles and is resistant to heat-checking. Disc brakes shall be totally enclosed and have multiple discs with stationary releasing magnets. Brake torque shall be easily adjustable over a 2:1 torque range.

2.3.7.1 Hoist Holding Brakes

Each hoist shall be equipped with at least 1 holding brake. Holding brake shall be disc or shoe design, applied to one of the following: motor shaft or gear reducer shaft or rope drum. Braking system shall be designed to have zero hook lowering motion when a raise motion is initiated. Primary brake shall be a spring-set, electrically-released, disc or shoe type brake. Brake shall have a minimum torque rating of 150 percent of motor torque. Brake shall be capable of holding the rated load with zero hook drift. Primary brake shall be automatically set when controls are released or when power is interrupted. Provisions shall be made to facilitate easy brake adjustment. Hoists shall be furnished with mechanical-control braking or a power-control braking system. Typical power means include dynamic lowering, eddy-current braking, counter-torque, regenerative braking, variable frequency, and adjustable or variable voltage.

2.3.7.2 Hoist Control Brake

Each hoist shall be provided with electrically-controlled braking system to prevent overspeeding.

2.3.7.3 Trolley Brake

Trolley braking system shall be provided with electrically-operated and hydraulically-operated shoe brakes or disc brakes. Hydraulic portion of braking system shall be designed so that the shoes will become disengaged by spring pressure and set by hydraulic pressure. Electrical portion of the braking system shall be designed such that the shoes will be spring-applied and electrically-released. Braking system shall be automatically set when controls are released or power is interrupted. Provisions shall be made to facilitate easy brake adjustment. Brakes shall have a torque rating of at least 50 percent of trolley drive motor rated torque.

2.3.7.4 Bridge Brakes

Bridge braking system shall be provided with electrically-operated and hydraulically-operated shoe or disc brakes. Hydraulic portion of braking system shall be designed so that the shoes will be disengaged with spring pressure and set with hydraulic pressure. Electrical portion of braking system shall be designed so that the shoes will be spring-applied and electrically-released. Braking system shall be automatically set when controls are released or power is interrupted. Provisions shall be made to facilitate easy brake adjustment. Brakes shall have a torque rating of at least 50 percent of bridge drive motor rated torque.

2.3.8 Wheels

Wheels shall be manufactured of rolled or forged steel. Wheel treads and flanges shall be rim toughened to between 320 and 370 Brinell hardness number. Trolley wheels shall have straight treads. Bridge wheels shall have straight treads. Wheels shall be equipped with self-aligning double-row spherical roller-bearings of capacity as recommended by bearing manufacturer for design load of trolley or bridge.

2.3.9 Bearings

Bearings shall be antifriction type, except bearings which are subject only to small rocker motion. Equalizer sheaves shall be equipped with sintered oil-impregnated type bushings in accordance with ASTM B 438, ASTM B 439, or ASTM B 612.

2.3.10 Anti-Drip Provisions

Cranes shall be designed to preclude leakage of lubricants onto the lifted loads or the floor. Equipment and components which cannot be made leak-proof shall be fitted with suitable drip pans. Drip pans shall be manufactured of steel and designed to permit removal of collected lubricant.

2.3.11 Lubrication System

Splash-type oil lubrication system shall be provided for hoist, trolley and bridge gear cases; an oil pump shall be used on vertical-mounted gear cases exceeding two reductions. Oil pumps shall be the reversible type capable of maintaining the same oil flow direction and volume while being driven in either direction. Electric motor-driven pumps may be used when input shaft speed is too low at any operating condition to ensure adequate oil flow. In such applications, pump shall be energized whenever drive mechanism brakes are released.

2.4 ELECTRICAL COMPONENTS

2.4.1 Control Systems

2.4.1.1 Hoist Control System

Main hoist and auxiliary hoist motion control system shall be two speed, , with ac magnetic control of ac wound rotor motor. Control shall provide for reversing, and for a mechanical load brake.

2.4.1.2 Travel Control System

Bridge and trolley motion control system shall be two speed with ac magnetic control of squirrel cage motors.

2.4.2 Power Sources

2.4.2.1 System Supply Voltage

Cranes shall be designed to be operated from a 460 volt, three-phase, 60 Hz, alternating current system power source. Energy isolating devices for such machine or equipment shall be designed to accept a lockout device in accordance with NFPA 70.

2.4.2.2 Transformers

Transformers shall be dry type suitable for the application.

2.4.2.3 Power Rectifiers

Power rectifiers shall be provided where required to convert ac to dc. Active semiconductor devices shall be silicon type. Rectifiers for motor control system shall be three-phase full wave rectifiers. Rectifiers for brakes shall be single-phase full-wave or three-phase full-wave rectifiers. A single rectifier may be used in lieu of several smaller rectifiers; brakes shall be supplied from a different rectifier than the other equipment. Protective enclosures shall conform to the requirements of NEMA ICS 6 Type 12. Rectifying elements shall be hermetically-sealed and mounted on heat sinks cooled by natural convection or by mechanical means. Minimum protection for rectifiers shall consist of transient surge suppressors, and 100,000 AIC current-limiting 700V rectifier type fuses in the ac line. Minimum protection for main power rectifiers shall include a line isolation transformer of the type specifically designed for use with static conversion units. Individual diode sets and thyristors shall be protected by fuses on the ac side. Each rectifier bridge used in brake circuits (including overload protection) shall be rated for continuous-duty at a minimum of 150 percent of load rating, and for 1 minute at a minimum of 300 percent of load rating. Each rectifier or SCR bridge used in the control system shall be rated for continuous-duty at a minimum of 100 percent of the load rating, and for one minute at a minimum of 200 percent of load rating following 8 hours at 100 percent load. The dc rated output voltage shall not exceed 460 volts.

2.4.3 Motors

2.4.3.1 General Requirements

Motors shall be designed specifically for crane and hoist duty. Drain holes shall be provided at low points near each end. Inspection and service covers shall be provided with gaskets. Hardware shall be

corrosion-resistant. Motors shall conform to the requirements of NEMA MG 1. Motor heaters shall be energized when mainline contactor is de-energized, and water heaters shall be de-energized when mainline contactor is de-energized. Motors 20 HP and larger shall be provided with a suitable heater to prevent condensation during long periods of inactivity. One thermal sensitive device embedded in hoist motor windings shall be provided. Device and associated circuitry shall serve as an alarm activating an amber signal or pilot light visible to control stations when motor temperatures become excessive. Set point shall be set below the Class B insulation temperature limit. Thermal-sensitive device and associated circuits shall be self-restoring (automatic reset). Two-speed, two-winding motors with a solid-state control will not be allowed for creep-speed use.

2.4.3.2 Main Hoist Motor

Hoist motor shall be crane type, two-speed; two-winding, NEMA design D squirrel cage ac type or wound-rotor type ac type.

2.4.3.3 Bridge and Trolley Drive Motors

Bridge and trolley drive motors shall be two-speed; two-winding NEMA design B squirrel cage ac type rated.

2.4.3.4 Motor Enclosures

Motor enclosures shall be totally enclosed, fan cooled (TEFC).

2.4.3.5 Hoist Motor Insulation and Time Rating

Hoist motors shall be provided with insulation which has a Class F/60 minute minimum motor time rating based on an 80 degree C motor temperature rise above 40 degrees C ambient, with frame size selection based on continuous ratings.

2.4.3.6 Bridge and Trolley Motor Insulation and Time Rating

Bridge and trolley drive motors shall be provided with an insulation which has a Class F/60 minute minimum motor time rating based on 85 degrees C motor temperature rise above 40 degree C ambient with frame size selection based on continuous rating.

2.4.4 Control System

A separate controller shall be provided for each motor; a duplex type for 2-motor bridge drives and a quadraplex type for 4-motor bridge drives on ac central cranes. When 2-motor bridge drives are furnished and dc magnetic control is required, dc series-connected motors shall be provided. When 4-motor bridge drives are furnished and dc magnetic control is required, dc series-parallel connected motors shall be provided. Overload protection shall be in conformance with requirements of NEMA ICS 2 and NFPA 70. When contactors are used for starting, stopping and reversing, contactors shall be mechanically and electrically interlocked.

2.4.4.1 Control Panels

Control panels shall be fabricated of solid sheet steel designed and constructed to conform to requirements of NEMA ICS 6 Type 12. Thermostatically-controlled heaters to keep control enclosure temperatures at or above 0 degrees C shall be provided in each static crane control panel. Control

panel heaters shall be energized when mainline contactor is de-energized, and shall be de-energized when mainline contactor is energized to prevent anti-condensation. Control panel doors shall be hinged, equipped with gaskets and fitted with key-lock handle design, complete with a single key to open all locks.

2.4.4.2 Main Hoist Control

Hoist motor control system shall provide two speeds in each direction with an electrically-operated, full-magnetic, across-the-line reversing type starter. Electrical and mechanical interlocks shall be used to prevent the operation of high speeds and low speeds.

2.4.4.3 Bridge and Trolley Control

Bridge and trolley main control systems shall provide two speeds in each direction with an electrically-operated, full-magnetic, across-the-line reversing type starter.

2.4.4.4 Drift Point

Trolley and bridge main control systems shall have a drift point between OFF and first speed control point in each direction or shall have a separate pushbutton.

2.4.5 Pendant Control Station

2.4.5.1 General

Pendant control station enclosure shall be NEMA Type 1. Physical size of pendant shall be held to a minimum. A separate cable of corrosion-resistant chain consisting of minimum 1/4 inch wire shall be provided. Pendant station shall be attached to underside of crane bridge footwalk and shall hang vertically with bottom of pendant at 40 inches above floor. Weight of pendant shall not be supported by control cable.

2.4.5.2 Operating Pushbuttons

Operating pushbuttons shall be heavy-duty, dust-and-oil-tight type with distinctly-felt operating positions which meet requirements of NEMA ICS 2. Pendant control buttons shall be momentary pushbuttons. Pushbuttons (except the POWER-OFF button) shall be the recessed type to avoid accidental operation. Diameter of buttons shall be a size which will make operation possible with a thumb while holding the pendant with same hand. Nameplates shall be provided adjacent to each pushbutton. Barriers shall be provided on pendant between various pushbutton functions, except on elements mounted in junction box. In a multi-speed application, dual-position pushbuttons shall have a definite click-detent position for each speed. Pushbuttons shall be designed and manufactured not to hang up in control case. Pendant shall include a separate set of pushbuttons for each motion and for POWER-ON POWER-OFF. Pushbuttons shall be as follows:

- POWER-OFF.
- POWER-ON.
- Hoist-up.
- Hoist-down.
- Bridge-North.
- Bridge-South.

Trolley-Upstream.
Trolley-Downstream.

2.4.5.3 Light Indicators

Pilot lights shall meet heavy-duty requirements of NEMA ICS 2. One amber pilot light to indicate excessive hoist motor temperature shall be provided on pendant station. A bright red mushroom head shall be provided with the POWER-OFF pushbutton. A 2-position selector switch shall be provided to select between normal and micro-drive. A single green pilot light shall be provided to indicate all micro-drive clutches are engaged.

2.4.6 Protection

2.4.6.1 Main Line Disconnect

A main line disconnect consisting of a combination circuit breaker (50,000 AIC) and non-reversing starter, starter without overloads (mainline contactor) in NEMA Type 1 enclosure shall be provided. Mainline disconnect shall be controlled by a control circuit so that all crane motions will be stopped upon mainline undervoltage, overload, control circuit fuse failure, or operation of POWER OFF pushbutton. Mainline disconnect shall be equipped with energy isolating devices designed to accept lockout devices.

2.4.6.2 Isolation Transformer

The isolation transformer shall be an SCR drive type specifically designed for cranes, with a continuous rating which will exceed that required of the sum of rated full-load full-speed KVA of hoist plus 50 percent of rated full-load full-speed KVA of trolley and bridge motors plus the rated KVA of controls. Total KVA is then multiplied by 1.05 (efficiency factor). The isolation transformer shall be connected to load side of mainline disconnect of the transformer. Crane dc static control electric power distributed on the crane shall be supplied through this isolation transformer.

2.4.6.3 Surge Protection

Surge suppressors shall meet the requirements of UL 1449. Three metal oxide varistors shall be provided on the line side of each SCR drive isolation transformer to provide transient over-voltage protection.

2.4.6.4 Circuit Breakers

Circuit breakers shall meet the requirements of UL 489.

2.4.6.5 Overloads

Alternating current circuit overload relays shall be of the ambient compensated, automatic reset, inverse time type located in all phases individual motor circuits. Overload relays shall be arranged to de-energize the associated motor on an overload condition. An automatically reset inverse time-trip running overload relay shall be provided for each dc motor circuit. An automatically reset instantaneous trip overload relay shall be provided in each dc motor circuit or for a pair of series-connected motors. Overload relays shall be arranged to de-energize the associated motor on an overload condition

2.4.7 Limit-Switches

Geared limit-switches shall be heavy-duty quick-break double-pole double-throw type conforming to NEMA ICS 2. The geared limit-switch interruption of a motion in one direction shall not prevent the opposite motion. Geared limit-switches shall reset automatically. Limit-switch housings shall be NEMA Type 1. Limit-switches shall interrupt power to the primary and micro-drive control systems.

2.4.7.1 Hoist Upper Limit-Switches

Two limit-switches shall be provided for each hoist. A rotating-type adjustable geared-control circuit interrupt limit-switch shall provide hoist-up limiting. A secondary hoist-upper-limit shall be provided with a weight-operated power circuit limit-switch to prevent the hoist from raising beyond the safe limit. The secondary limit-switch shall operate to interrupt power to all hoist motor conductors, set the hoist holding brakes and directly open all "raise" power circuits.

2.4.7.2 Hoist Lower Limit-Switches

Hoists shall be provided with a rotating-type adjustable geared-control circuit interrupt limit-switch for hoist-down travel limiting. The hook downward vertical travel of the hook shall be field-adjustable to approximately 6 inches above working surface.

2.4.7.3 Bridge and Trolley Travel Limit-Switches

Runway (track-type) limit-switches shall be provided for crane bridge and trolley motions to stop the bridge and trolley motions, respectively. Limit-switch actuators shall be installed on building and trolley frame to actuate the limit-switches and stop the crane bridge or trolley prior to contacting the trolley frame bumpers. Trip mechanism for trolley motion shall be located on crane runway to trip the switch before the bumper contacts the stop. Trip mechanism for bridge motion shall be located on crane runway to trip switch before bumper contacts the stop. When the switch is tripped, the switch shall permit opposite travel in the direction of stop and then automatically reset.

2.4.8 Wiring

Wires shall be numbered or tagged at connection points. Splices shall be made in boxes or panels on terminal boards or standoff insulators. Motor loop, branch circuit and brake conductor selection shall be based on NFPA 70 for 90 degree C conductor rating on indoor cranes, and for 75 degree C conductor rating on outdoor cranes. Wire insulation shall be Type XHHW. Conductors in the vicinity of resistors and conductors connected to resistors shall be Type 5RML.

2.4.9 Electrification

2.4.9.1 Main Power Electrification

Main power electrification system shall provide power to crane starter/disconnect circuit breaker.

2.4.9.2 Crane Runway Conductors

Crane runway conductor system shall be the covered conductor bar system type designed and manufactured to meet UL requirements. Protective covers shall be the rigid or flexible self-closing type designed to cover all live conductors and shall be shaped to prevent accidental contact with conductors. Collectors shall be heavy-duty sliding shoe type compatible with the electrification

system. Two tandem designed collector heads shall be provided for each conductor rail to provide redundancy.

2.4.9.3 Bridge Span Conductors

Bridge span conductor system shall be the rigid conductor/collector type. Cable loops shall not drop below the hook high position. Outdoor crane bridge festoon system hardware shall be corrosion resistant.

2.4.10 Special Requirements

2.4.10.1 Warning Horn

A solid-state electronic warning horn shall be provided on the crane. Any bridge or trolley motion shall be accompanied by a continuous series of alternating tones. The warning horn shall not sound when the crane is in the micro-drive mode.

2.4.10.2 Anti-Condensation Heaters

Motor and control panels shall be equipped with anti-condensation heaters. Thermostatically-controlled heaters shall be provided in each static-control panel to keep control enclosure temperatures at or above 0 degrees C. Circuit breaker combination magnetic starter shall be NEMA Type 1 enclosure. Magnetic starter shall be equipped with manually-reset overload relays and interlocked with the mainline disconnect so that anti-condensation heaters are de-energized when the mainline contactor is energized and the magnetic starter is energized when the mainline contactor is de-energized.

PART 3 EXECUTION

3.1 ERECTION

The entire crane erection shall be performed in accordance with manufacturer's instructions under the full-time supervision of the manufacturer's representative. Contractor shall provide a written certificate from crane manufacturer indicating the crane is erected in accordance with manufacturer's recommendations before testing the completed installation.

3.1.1 Shop Assembly

Major crane components shall be shop assembled as completely as possible. Disassembled parts shall be match marked and electrical connections tagged after complete no-load shop testing. Parts and equipment at site shall be protected from weather, damage, abuse and loss of identification. Erection procedures shall ensure that the crane is erected without initial stresses, forced or improvised fits, misalignments, nicks of high-strength structural steel components, stress-raising welds and rough burrs. Damaged painted surfaces shall be cleaned and repainted after crane is erected.

3.1.2 Mechanical Alignment

Motors, couplings, brakes, gear boxes and drive components shall be aligned when reinstalled in accordance with manufacturer's instructions.

3.1.3 Electrical Alignment

Control system shall be aligned in accordance with manufacturer's instructions. A copy of the final alignment data shall be stored in control panel door and shall include but not be limited to timer settings, resistor tap settings, potentiometer settings, test-point voltages, supply voltages, motor voltages, motor currents and test conditions such as ambient temperature, motor load, date performed and person performing the alignment.

3.1.4 Welding

Welders, welding operations and welding procedures shall be qualified or prequalified in accordance with AWS D14.1. Welding shall be performed indoors and the surface of parts to be welded shall be free from rust, scale, paint, grease or other foreign matter. Minimum preheat and interpass temperatures shall conform to the requirements of AWS D14.1. Welding shall be performed in accordance with written procedures which specify the Contractor's standard dimensional tolerances for deviation from camber and sweep. Such tolerances shall not exceed those specified in accordance with AWS D14.1. Allowable stress ranges shall be in accordance with MHI CMAA 70. Welding of girders and beams shall conform with AWS D14.1.

3.1.5 Field Painting

Painting required for surfaces not otherwise specified, and finish painting of items only primed at the facility, shall be as specified in Section 09900 PAINTING, GENERAL. Bridge crane including bridge, trolley, hoist and all attached items shall be painted in accordance with the manufacturer's standard practice. The complete crane shall be of one color. Bridge rail, supports and bracing shall be painted in accordance with Section 09900 PAINTING, GENERAL. Items such as surfaces in contact with the rail wheels, wheel tread, hooks, wire rope, surfaces on the electrical collector bars in contact with the collector shoes and nameplates shall not be painted. The requirements of explosion proof cables shall be coordinated with cable manufacturer.

3.2 ACCEPTANCE TESTING

3.2.1 General

Contractor shall provide all personnel necessary to conduct the required testing which shall include but not be limited to crane operators, riggers, rigging gear and test weights. Testing shall be performed in the presence of Contracting Officer or his designated representative. Contractor shall notify Contracting Officer 30 days prior to testing operations. Contractor shall operate all equipment and make all necessary corrections and adjustments prior to the testing operations witnessed by Contracting Officer. A representative of the Contractor responsible for procuring and installing hoist equipment shall be present to direct the field testing. Test loads shall be compact and permit a minimum of 50 percent of the vertical lift travel distance. Test loads shall be minus 0 percent to plus 5 percent of the required weight, and shall be verified prior to testing. Test weights required are 2.5 tons, 25 tons, and 31.25 tons. Operational testing shall not be performed until after building interior has been painted. Three (3) copies of all test reports shall be furnished to Contracting Officer.

3.2.1.1 Test Sequence

Crane shall be tested in accordance with applicable paragraphs of this procedure in the sequence provided.

3.2.1.2 Test Data

Operating and startup current measurements shall be recorded for coils, hoist, trolley, and bridge motors using the appropriate instrumentation. Speed measurements shall be recorded as required by facility evaluation tests (normally at 100 percent load). Recorded values shall be compared with design specifications or manufacturer's recommended values and the abnormal differences shall be justified in the remarks or appropriate adjustments performed. The high temperatures or abnormal operation of any equipment or machinery shall be noted, investigated and corrected. Hoist, trolley and bridge speeds shall be recorded during each test cycle.

3.2.1.3 Equipment Monitoring

Improper operation or poor condition of safety devices, electrical components, mechanical equipment and structural assemblies shall be monitored during the load test. Defects observed to be critical during the testing period shall be reported immediately to the Contracting Officer and the testing operations shall be suspended until the defects are corrected. During each load test and immediately following each load test, the following inspections shall be made:

- a. Inspect for evidence of bending, warping, permanent deformation, cracking or malfunction of structural components.
- b. Inspect for evidence of slippage in wire rope sockets and fittings.
- c. Check for overheating in brake operation; check for proper stopping. All safety devices including emergency stop switches and POWER-OFF pushbuttons shall be tested and inspected separately to verify proper operation of the brakes. When provided, safety accessories including warning horn, lighting, gauges, warning lights and accuracy of wind indicating device and alarm shall be inspected.
- d. Check for abnormal noise or vibration and overheating in machinery drive components.
- e. Check wire rope sheaves and drum spooling for proper reeving and operation, freedom of movement, abnormal noise or vibration.
- f. Check electrical drive components for proper operation, freedom from chatter, noise, overheating, and lockout/tagout devices for energy isolation.
- g. Inspect gears for abnormal wear patterns, damage, or inadequate lubrication.
- h. Verify that locations of crane capacity plates are visible from pendant operator's position.

3.2.1.4 Hooks

Hooks shall be measured for hook throat spread before and after load test. A throat dimension base measurement shall be established by installing two tram points and measuring the distance between the tram points to within 1/64 inch. This base dimension shall be recorded. Distance between tram points shall be measured before and after load test. An increase in throat opening by more than 1 percent from base measurement shall be cause for rejection.

3.2.2 No-Load Testing

3.2.2.1 Hoist Operating and Limit Switch Test

Load hook shall be raised and lowered through the full range of normal travel at rated speed and other crane speeds. Load hook shall be stopped below the geared limit-switch upper setting. In slow speed only, proper operation of upper and lower limit-switches for primary and micro-drive motions shall be verified. The test shall be repeated a sufficient number of times (minimum of 3) to demonstrate proper operation. Brake action shall be tested in each direction. Proper time-delay shall be verified between the actuation of dual brakes.

3.2.2.2 Trolley Travel

Trolley shall be operated the full distance of bridge rails exercising all primary drive and micro-drive speed controls in each direction. Brake operation shall be verified in each direction. In slow speed or micro-drive, trolley bumpers shall contact trolley stops located on the bridge girders. In slow speed the proper operation (interrupt power, automatic reset) of the trolley limit-switches at both limits of trolley motion shall be tested.

3.2.2.3 Bridge Travel

Bridge shall be operated in each direction the full distance of runway exercising all primary drive and micro-drive speed controls. Brake operation shall be verified in each direction. In slow speed the proper operation (interrupt power, automatic reset) of the bridge limit-switches at both limits of bridge motion shall be tested. In slow speed or micro-drive the crane bridge bumpers shall contact the runway rail stops.

3.2.2.4 Hoist Loss of Power No-Load Test

Using the primary drive, hooks shall be raised to a height of approximately 12 feet or less. While slowly lowering the hook the main power source shall be disconnected, verifying that the hook will not lower and that both brakes will set. Test shall be repeated using micro-drive controls.

3.2.2.5 Travel Loss of Power No-Load Test

With the hook raised to clear obstructions and trolley traveling in slow speed, the main power source shall be disconnected, verifying that the trolley will stop and the brake will set. Test shall be repeated for trolley using micro-drive speed. Test shall be repeated for bridge, micro-drive and slow speed primary drive controls.

3.2.3 Load Test

3.2.3.1 Hoist

Unless otherwise indicated, the following tests shall be performed using a test load of 125 percent (plus 5 percent, minus 0 percent) of rated load.

- a. Hoist Static Load Test: Holding brakes and hoisting components shall be tested by raising the test load approximately 1 foot and manually releasing one of the holding brakes. Load shall be held for 10 minutes. First holding brake shall be reapplied and second holding

brake released. Load shall be held for 10 minutes. Any lowering that may occur indicates a malfunction of brakes or lowering components.

- b. Dynamic Load Test: Test load shall be raised and lowered through the full range operating in each speed. Machinery shall be completely stopped at least once in each direction to ensure proper brake operation.
- c. Hoist Mechanical Load Brake: With test load raised approximately 5 feet and with the hoist controller in the neutral position, holding brake shall be released. Mechanical load brake shall be capable of holding the test load. With holding brake in released position, test load shall be lowered (first point) and the controller shall be returned to OFF position as the test load lowers. Mechanical load brake shall prevent the test load from accelerating.
- d. Hoist Loss of Power Test: After raising test load to approximately 8 feet, slowly lowering the test load, the main power source and control pushbutton shall be released verifying that the test load will not lower and that both brakes will set. Test shall be repeated using micro-drive controls.
- e. Trolley Dynamic Load Test: While operating the trolley the full distance of bridge rails in each direction with test load on the hook (one cycle), proper functioning of all primary drive and micro-drive speed control points and proper brake action shall be tested.
- f. Bridge Dynamic Load Test: With test load on hook, bridge shall be operated for the full length of runway in both directions with trolley at each extreme end of bridge. Proper functioning of all primary drive and micro-drive speed control points and brake action shall be verified.

3.2.3.2 Trolley and Bridge Loss of Power Test

A test load of 100 to 105 percent of rated load shall be raised clear of any obstructions on operating floor. Starting at a safe distance from walls or other obstructions, a slow speed shall be selected using the trolley and bridge primary drive. While maintaining a safe distance to obstructions, the main power source shall be disconnected and brakes shall be verified to have set and that the equipment stops within the distance recommended by manufacturer.

3.2.4 Overload Tests

After the operational tests, bridge crane system and all functions of bridge crane shall be tested at 125 percent of rated load.

3.2.5 Acceleration and Deceleration Tests

The acceleration and deceleration of bridge and trolley shall be tested with approximately 10 percent of rated load at lowest possible location of hook. Bridge and trolley shall be operated to run up to high speed and then stopped without jarring or swinging the load.

3.2.6 Grounding Test

Hoist shall be tested to determine that the hoist, including hook and pendant, are grounded to building during all phases of hoist operation. The grounding of bridge and trolley shall be tested with

approximately 10 percent of rated load on hook. Grounding shall be tested between hoist hook and the structure's grounding system.

3.2.7 Adjustments and Repairs

Adjustments and repairs shall be performed by Contractor under the direction of the Contracting Officer at no additional cost to the Government, until satisfactory conditions are maintained, and contract compliance is affected. After adjustments are made to assure correct functioning of the components, pertinent testing shall be repeated.

3.3 SCHEMATIC DIAGRAMS

Schematic diagrams for equipment shall be furnished.

3.4 MANUFACTURER'S FIELD SERVICE REPRESENTATIVE

Contractor shall furnish a qualified experienced manufacturer's field service representative to supervise the crane installation, assist in the performance of the on-site testing, and instruct personnel in the operational and maintenance features of the equipment.

3.5 FIELD TRAINING

Contractor shall conduct a training course for the operating staff. Training period shall consist of a total of 4 hours of normal working time and shall start after the system is functionally completed but prior to final acceptance. Course instructions shall cover pertinent points involved in operating, starting, stopping, and servicing the equipment, including all major elements of operation and maintenance manual. Course instructions shall demonstrate all routine maintenance operations such as lubrication, general inspection, and scheduling. Contracting Officer shall be given at least 2 weeks advance notice of field training.

3.6 ACCEPTANCE

Final acceptance of crane system will not be given until Contractor has successfully completed all testing operations, corrected all material and equipment defects, made all proper operation adjustments, and removed paint or overspray on wire rope, hook and electrical collector bars.

End of Section

DIVISION 15 - MECHANICAL

SECTION 15160

VERTICAL PUMPS, MIXED-FLOW IMPELLER-TYPE

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SECTION 15160

VERTICAL PUMPS, MIXED-FLOW IMPELLER-TYPE

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

ACOUSTICAL SOCIETY OF AMERICA (ASA)

ASA S2.19	(R1997) Mechanical Vibrations - Balance Quality Requirements of Rigid Rotors, Part 1: Determination of Permissible Residual Unbalance
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AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 27	(1995) Steel Castings, Carbon, for General Applications
ASTM A 36	(1996) Structural Steel
ASTM A 48	(1994a) Gray Iron Castings
ASTM A 108	(1995a) Steel Bars, Carbon, Cold Finished, Standard Quality
ASTM A 268	(1996) Seamless and Welded Ferritic and Martensitic Stainless Steel Tubing for General Service
ASTM A 276	(1997) Stainless and Heat-Resisting Steel Bars and Shapes
ASTM A 285	(1996) Pressure Vessel Plates, Carbon Steel, Low- and Intermediate-Tensile Strength
ASTM A 297	(1993)e1 Steel Casting, Iron-Chromium and Iron-Chromium-Nickel, Heat Resistant, for General Application
ASTM A 312	(1995a)e1 Seamless and Welded Austenitic Stainless Steel Pipes
ASTM A 516	(1996) Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service
ASTM A 576	90b(1995)e1 Steel Bars, Carbon, Hot-Wrought, Special Quality

ASTM A 668	(1996)e1 Steel Forgings, Carbon and Alloy, for General Industrial Use
ASTM B 148	(1997) Aluminum-Bronze Sand Castings
ASTM B 584	(1996) Copper Alloy Sand Castings for General Applications
ASTM D 2000	(1998) Rubber Products in Automotive Applications
ASTM E 709	(1995) Magnetic Particle Examination

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME-16	(1998) Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels Division 1 - Basic Coverage
ASME-17	(1995) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications
ASME B4.1	(R 1994) Preferred Limits and Fits for Cylindrical Parts
ASME B46.1	(1995) Surface Texture (Surface Roughness, Waviness, and Lay)
ASME B106.1M	(1985) Design of Transmission Shafting (Second Printing)

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1	(1998) Structural Welding Code - Steel
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AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C200	(1986) Steel Water Pipe 6 In. and Larger
AWWA C203	(1991) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied
AWWA C207	(1986) Steel Pipe Flanges for Waterworks Service - Sizes 4 Inch through 144 Inch
AWWA C208	(1983; R 1989) Dimensions for Fabricated Steel Water Pipe Fittings

FEDERAL SPECIFICATION (FS)

FS TT-E-2784	(Rev A) Enamel (Acrylic-Emulsion, Exterior Gloss and Semigloss) (Metric)
FS TT-P-38	(Rev E) Paint, Aluminum (Ready-Mixed)

HYDRAULIC INSTITUTE (HI)

HI-01 (1983) Standards for Centrifugal, Rotary & Reciprocating Pumps

MILITARY SPECIFICATION (MS)

MS MIL-B-131 (Rev H; Int Amt 1) Barrier Materials Water-vapor-proof, Greaseproof, Flexible, Heat Sealable

MS MIL-C-104 (Rev B; Amd 1) Crate, Wood, Lumber and Plywood Sheathed, Nailed and Bolted

MS MIL-C-18480 (Rev B; Notice 1) Coating Compound, Bituminous, Solvent, Coal-Tar Base

MS MIL-D-3464 (Rev A) Desiccants, Activated, Bagged, Packaging Use and Static Dehumidification

MS MIL-I-8835 (Rev A) Indicator, Humidity, Card, Chemically Impregnated

MS MIL-W-48302 (Notice 1) Window, Observation

STEEL STRUCTURES PAINTING COUNCIL (SSPC)

SSPC Paint 25 (1991) Red Iron Oxide, Zinc Oxide, Raw Linseed Oil and Alkyd Primer (without Lead and Chromate Pigments)

SSPC SP 5 (1991) White Metal Blast Cleaning

SSPC SP 7 (1991) Brush-Off Blast Cleaning

1.2 SYSTEM DESCRIPTION

Design, furnish, and install 3 identical vertical mixed-flow, single-stage impeller-type pumps.

1.2.1 Design Requirements

- a. Pumps are for the purpose of pumping floodwater from the New Madrid drainage basin into the Mississippi River. Water pumped will not exceed 90 degrees F, will be relatively turbid, and may contain sand, silt, and vegetative trash capable of passing trashrack. Trash-racks will have 3 1/2-inch clear openings. Pumps shall be designed to operate in the dry.
- b. Pumps shall be driven by the horizontal induction motors described in Section 15170 ELECTRIC MOTORS, 3-PHASE HORIZONTAL INDUCTION TYPE through right angle, vertical shaft, reducers described in Section 11212 SPEED REDUCERS FOR STORM WATER PUMPS.
- c. Design pump so that no major modifications, alterations, or additions will be required to the pumping station or suction bays to accommodate it. However, requests for changes in setting of pump, supports, and accessories, which would involve only minor modifications,

will be considered. Design pump so that pump parts will fit within the limiting horizontal and vertical dimensions shown and so installation and maintenance can be accomplished by interior; overhead traveling crane. Pumps, or pump parts assembled at pumping station shall be capable of being lowered through floor openings shown with minimum of 1 inch clearance around each side.

- d. Pump shall discharge into discharge chamber shown. System loss curve(s) furnished includes all losses beyond the discharge elbow. Losses within the pump including the format section inlet (FSI) shall be determined by the Contractor.
- e. Priming of siphon will be accomplished without assistance of vacuum equipment.

1.2.2 Performance Requirements

- a. Maximum level of vibration of assembled pumping unit, consisting of pump, gear reducer, and motor, when tested in the dry as specified in paragraph FIELD TESTS, subparagraph DRY TESTS, shall not be greater than the value of lower limit of the "good" range of "General Machinery Vibration Severity Chart". Make measurements at pump operating speed. "General Machinery Vibration Severity Chart" may be obtained from IRD Mechanalysis Inc., 6150 Huntly Rd., Columbus, Ohio 43229.
- b. Pump shall be capable of operation without instability over the entire range of heads specified in paragraph 1.2.3. Instability is defined, for this specification, as when one or more of the following conditions occur: pump has two or more flow rates at the same total head; head-capacity curve has a dip (region on curve where change in flow rate produces an abnormally low head); when any point in usable range of head-capacity curve cannot be repeated within 5 percent; when a test point deviates from normal curve by 5 percent.

1.2.3 Capacities

The pump shall:

- a. Discharge not less than 500 cubic feet per second against a total head corresponding to a static head of 17.5 feet with water surface in sump at elevation of 278.0 NGVD (Design Conditions).
- b. Discharge against a total head corresponding to a static head of 30 feet with water surface in sump elevation 278.0 NGVD (Maximum Head).
- c. Discharge against a total head corresponding to a static head of 22.5 feet with water surface in sump elevation 275.0 NGVD (Minimum Submergence).
- d. Discharge against a total head corresponding to a static head of 6.6 feet with water surface in sump elevation 290.9 NGVD (Maximum Flow).

1.3 SUBMITTALS

Government approval is required for all submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Lists of Materials; FIO.

Furnish two copies of purchase orders, mill orders, shop orders for materials, and work orders, including orders placed or extended by each supplier. Contractor shall at time of submittal of drawings furnish list designating materials to be used for each item.

Materials; GA.

Furnish, within 60 days of notice of award, names of manufacturers of machinery and other equipment which Contractor contemplates incorporating in the work, together with performance capacities and other relevant information pertaining to the equipment.

Spare Parts; FIO.

Furnish six (6) copies of manufacturer's complete parts list showing all parts and spare parts and bulletins for pump. Clearly show all details and parts, and adequately describe parts or have proper identification marks.

Torsional Analysis; GA.

Submit detailed analysis report.

SD-04 Drawings

Drawings; GA.

Within 90 days of notice of award of contract, submit drawings listed below. Submit drawings of sufficient size to be easily read. Submit information in the English language. Dimensions shall be in English. Drawings requiring changes as a result of model test should be submitted within 45 days after approval of model test.

- a. Outline drawings of pump showing pertinent dimensions and weight of each component of the pump.
- b. Drawing showing details and dimensions of pump mounting design or layout including any embedded items (and the FSI).
- c. Cross-sectional drawings of pump showing each component. Show major or complicated sections of pump in detail. Indicate on each drawing an itemized list of components showing type, grade, and class of material used and make and model number of standard component used.
- d. Detail and assembly drawings of entire pump. Include all dimensions required to manufacture pump.
- e. Drawings covering erection and installation, which Contractor intends to furnish to erecting engineer.

SD-06 Instructions

Installation and Erection Instructions Manual; GA.

No later than time of pump delivery, furnish three copies of typed or printed, and bound, manual describing procedures to be followed by erecting engineer in erecting, assembling, installing, and dry- and wet-testing pump. To the extent necessary or desirable, coordinate and consolidate description of pump with similar descriptions specified for motor and for gear reducer.

Description shall be complete, orderly, step-by-step explanation of operations required, and shall also include such things as alignment procedures, bolt torque values, permissible blade/bowl clearances; permissible bowl out-of-roundness; permissible shaft misalignment; recommended instrument setups; recommended gages and instruments; bearing clearances; and similar details.

Description shall be complemented and supplemented by drawings, sketches, photos, and similar materials to whatever extent necessary or desirable, and the overall result shall be a description that may be comprehended by an engineer or mechanic without extensive experience in erecting or installing pumps of this type.

SD-08 Statements

External Column Bracing; GA.

The design of the external column bracing and its connection to the sump walls shall be submitted to Contracting Officer.

Factory Test Setup and Procedures

The Contractor shall, prior to proceeding with the construction of the model, but not later than 90 days after the date of notice to proceed, submit to the Contracting Officer for approval a description of the proposed model and test procedure. Included therein shall be dimensioned drawings and cross-sectional views of the model pump showing the location of all instruments and the point of their connection to the model.

Castings and Casting Repairs; GA.

The Contractor shall submit criteria for acceptance of castings and casting repairs, including welding procedure for each material used, to Contracting Officer for approval within 120 days of date of notice to proceed.

SD-14 Samples

Materials; GA.

Submit samples of materials as directed. Equipment, materials, and articles installed or used without the approval of the Contracting Officer shall be at risk of subsequent rejection.

SD-19 Operation and Maintenance Manuals

Operating and Maintenance Instructions; FIO.

Furnish 10 copies of manual containing complete information on operation, lubrication, adjustment, routine and special maintenance, disassembly, repair, reassembly, and trouble diagnostics of pump and auxiliary units. Operation and maintenance manual and both parts lists shall be bound separately, shall be approximately 8-1/2 inches by 11 inches, printed on good quality paper and bound between flexible, durable covers. Drawings incorporated in manual or parts lists, may be reduced to page size provided they are clear and legible, or may be folded into the manual to page size. Photographs or catalog cuts of components may be included for identification.

1.4 QUALIFICATIONS

Welding operators, welders, and tack welders shall be qualified and, as necessary, requalified for the particular type of work. Qualification shall be in accordance with one of the following codes: Part III, Section 5 of AWS D1.1; or Section IX of ASME-17. Contractor shall certify by name to Contracting Officer the welders and welding operators so qualified, including date of qualification, code, and procedures under which each qualified. Prior qualification may be accepted provided the welder has performed satisfactory work under the code for which he qualified within the preceding three months. Contractor shall require welder or welding operator to repeat qualifying tests when, in the opinion of Contracting Officer, work indicates reasonable doubt as to welder's proficiency. In such cases, welder shall be recertified as required above. The welder shall be considered disqualified until successful completion of retest. All expenses in connection with qualification and requalification shall be borne by Contractor.

1.5 REGULATORY REQUIREMENTS

The Contractor shall comply with the following requirements:

- a. Engineer Manual, EM 385-1-1, "Safety and Health Requirements Manual".
- b. Engineer Manual, EM 110-2-3105, "Mechanical and Electrical Design of Pumping Stations (1962).
- c. Federal Acquisition Regulation, FAR 52.246-2, "Inspection of Supplies - Fixed Price".
- d. Department of the Army, Technical Manual, TM 5-809-10, "Seismic Design for Buildings" (February 1982).

1.6 DELIVERY, STORAGE AND HANDLING

Furnish shipping bills or memorandums of all shipments of finished pieces or members to designated site, giving designation mark and weight of each piece, number of pieces, total weight, and if shipped by rail in carload lots, car initial and number.

1.6.1 Processing for Storage

1.6.1.1 General

Prepare pump parts for storage outdoors. Unless this processing is as described below, furnish to Contracting Officer for approval, a minimum of 60 days prior to shipment, a complete description of processing method to be used, including complete instructions for maintaining protection. After application of preservatives, seal pump parts, accessories, auxiliaries, and spare parts in bags with a supply of desiccant. "Pump parts" means pump parts, accessories, auxiliaries, and spare parts that

would be subject to damaging effects of corrosion, such as rust or oxidation. "Crate," means export-type boxing crate, meeting MS MIL-C-104, "Type 1," "Class 2," "Style A," except as modified below:

- a. Provide door or other suitable access, fitted with hasp, staple, and padlock, if size permits. Key padlocks alike and furnish four keys for each lock.
- b. No ventilation openings shall be provided.
- c. Provide openings fitted with removable covers so that wire ropes or slings can be attached to hoisting or skidding devices to facilitate loading, unloading, and handling.

1.6.1.2 Shaft Storage

Provide pumps to be stored completely assembled with enough support to the shaft so that it will not warp during 12 months of storage. Prepare shaft for shipment and storage to prevent damage such as bending, deforming machined surfaces, or corrosion. Provide detailed handling instructions for shipment, unpacking, assembly, and disassembly and attach to each shaft section or container.

1.6.1.3 Storage Bags

Fabricate bags of vapor barrier material meeting MS MIL-B-131. Fabricate pump parts storage bag by placing vapor barrier material between pump parts and bottom of crate. Extend sufficient length of vapor barrier material from under pump parts to allow attachment of side sheets. Prior to forming bag around pump parts, use cushioning to cover sharp edges and other parts of assembly that might pierce or rupture bag. Attach cushioning by taping, tying, stapling, or another suitable method. Provide gasketed openings for bolts or other devices or members that extend through bag for airtight seal. Large, bulky or heavy pump parts which are skid-mounted separately from other parts shall be provided with similar bags. During the final sealing operation, take care to prevent reentrance of air. Do not enclose small parts in storage bag of a larger part for shipping purposes. Box and ship small parts separately. Mark bags in large conspicuous letters: "PACKAGED WITH DESICCANT - DO NOT OPEN WITHOUT APPROVAL OF CONSTRUCTION DIVISION, MEMPHIS DISTRICT". Place markings near each pump part crate access door, if applicable, on sides and top of pump parts which are separately skid-mounted, and on top and sides for boxed pump parts.

1.6.1.4 Desiccant

Upon completion of necessary cushioning, place desiccant meeting MS MIL-D-3464 in each storage bag and securely attach by taping, tying, wiring, strapping, or another approved means. Take care to prevent desiccant bags from touching critical surfaces. Minimum amount of desiccant to be used shall be determined as follows:

$$U = CA + XD$$

Where U is minimum number of units of desiccant to be used. A unit is that quantity of desiccant that will absorb, at equilibrium with air and at 77 degrees F, at least 3.00 grams of water vapor at 20 percent relative humidity and 6.00 grams at 40 percent relative humidity.

$$C = 0.011 \text{ when area of barrier is in square inches}$$

$$C = 1.6 \text{ when area of barrier is in square feet}$$

A = Area of barrier in square inches or square feet

X = Factor for dunnage

X = 8 for hair felt, cellulosic material, and other material not categorized below

X = 6 for bond fibers (animal hair, synthetic fiber or vegetable fiber bound with rubber)

X = 2 for glass fiber

X = 0.5 for synthetic foams and rubbers

D = Pounds of dunnage (other than metal) within barrier

In no case shall amount of desiccant be less than required to provide an initial relative humidity of 20 percent. Locate desiccant bags uniformly throughout vapor barrier bag and so that all voids are exposed to dehydrating action of the material. Bags of desiccant shall be as small as practicable.

1.6.1.5 Inspection Windows

Provide inspection windows meeting MS MIL-W-48302 for "Class 1" and install in each storage bag using either heat-sealing technique or cement compatible with both window and vapor barrier materials, and specially suited for the purpose. Windows shall be of sufficient size, and located in sufficient number to permit general observation of protected items or material and viewing of humidity indicators described below.

1.6.1.6 Humidity Indicators

Provide humidity indicators of three-spot paper card type, approximately 2 inches by 4 inches, conforming to MS MIL-I-8835, in each storage bag. One card will be sufficient for small bags, but two or more cards shall be provided in larger bags. Locate card behind inspection windows and as far as practicable from desiccant bags.

1.7 PROJECT/SITE CONDITIONS

1.7.1 Datum

Elevations shown or referred to in specifications, are above or below National Geodetic Vertical Datum (NGVD).

1.7.2 Static Head

Static head is the difference, in feet, between water surface elevation immediately inside trashrack and water surface elevation of discharge chamber. Total head includes static head, friction losses outside of equipment being furnished, plus velocity head loss. A curve showing friction losses plus velocity head for pumped capacities is included at the end of this section.

1.8 MAINTENANCE

1.8.1 Special Tools

Furnish one set of all "special tools" required to completely assemble, disassemble, or maintain pump. "Special tools" refer to grossly oversized or specially dimensioned tools, special attachment or fixtures, or any similar items. If required, provide a device for temporarily supporting pump shaft and impeller during assembly, disassembly, and reassembly of gear reducer when thrust bearing is not in place. Lifting devices required for use in conjunction with overhead crane shall be furnished. Provide portable steel cabinet large enough to accommodate all "special tools" furnished under this paragraph and as required by Section(s) 15170 ELECTRIC MOTORS 3-PHASE HORIZONTAL INDUCTION TYPE, and 11212 SPEED REDUCERS FOR STORM WATER PUMPS. Mount cabinet on four rubber-tired casters. Provide drawers to accommodate tools. Fit front of cabinet with doors hinged to swing horizontally. Furnish doors with necessary stops, catches, and hasps for completely securing cabinet with a padlock. Furnish padlock complete with three keys. Pack "special tools" in wooden boxes if size and weight do not permit storage in tool cabinet. Provide slings if box and tools are heavier than 75 pounds.

1.9 ERECTION ENGINEER(S)

Furnish one or more competent erecting engineers fluent in English language who is knowledgeable about the installation of the vertical pumps and associated drive machinery. Erecting engineers provided by this section shall include those from Contractor's suppliers. When so requested, erecting engineers shall provide and be responsible for providing complete and correct direction during initial starting and subsequent operation of equipment until field tests are completed. Erecting engineer shall initiate instructions for actions necessary for proper receipt, inspection, handling, uncrating, assembly, and testing of equipment including instructions required to ensure compliance with paragraph REGULATORY REQUIREMENTS, EM 385-1-1. The Erecting Engineer(s) shall also keep a record of measurements taken during erection, and shall furnish one copy to Contracting Officer on request or on completion of installation of assembly or part. Erecting engineer shall instruct Contracting Officer in operation and maintenance features of work.

PART 2 PRODUCTS

2.1 MATERIALS AND METALWORK FABRICATION

Materials shall conform to requirements of paragraph REGULATORY REQUIREMENTS, subparagraph b., FAR 52.246-2, and to additional specified requirements. Classification and grade of material incorporated in work shall be in accordance with designated specifications. If Contractor desires to deviate from designated specifications, he shall, after award, submit to Contracting Officer for approval, complete specifications for proposed materials.

2.1.1 Designated Materials

Designated materials shall conform to the following specifications, grades, and classifications.

MATERIAL	GRADE	CLASS	SPECIFICATION
Aluminum-Bronze	Alloy No. C95500 Castings		ASTM B 148
Cast Iron		Class No.	ASTM A 48

		30A, 30B, and 30C	
Cast Steel	Grade 65-35 annealed		ASTM A 27
Coat Tar Protective Coatings - Hot Applies			AWWA C203
Cold-Rolled Steel Bars	min. Wt. Str. 65,000 psi		ASTM A 108
Copper Alloy Castings	Alloy No. C93700		ASTM B 584
Corrosion-Resistant Alloy Castings	Grade CA-15 CAGNM & CF-8M		ASTM A 297
Dimensions for Steel Water Pipe Fittings			AWWA C208
Hot-Rolled Stainless	Grades G10200 and G11410		ASTM A 576
Ring Flanges		Class B	AWWA C207
Rubber Products in Automotive Appl.			ASTM D 2000
Seamless and Welded Aust. Stainless Steel Pipe			ASTM A 312
Stainless Bars and Shapes	Grades S30400 and S41000		ASTM A 276
Steel Forgings		Class F	ASTM A 668
Steel Pipe 6 inches and Larger			AWWA C200
Steel Plates, Pressure Vessel	Grade 55		ASTM A 516
Steel Plates, Structural Quality	Grade B		ASTM A 285
Structural Steel			ASTM A 36

Surface Texture
(Surface Roughness,
Waviness, and Lay)

ASME B46.1

2.1.2 Castings

2.1.2.1 Cast or Stamp Mark Number

Cast or stamp mark number on each casting. Cast or stamp heat number on each casting weighing more than 500 pounds. Warped, distorted, or oversize castings that will interfere with proper fit with other parts of machinery or structure will be rejected. Cracked castings of nonweldable materials (cast iron, etc.) will be rejected. Repairs to castings shall not be made prior to approval by Contracting Officer.

2.1.2.2 Visually Examine

Visually examine each casting for defects. Examine visually defective propeller and other castings using Magnetic Particle Tests. Magnetic particle tests and inspection shall conform to Appendix 6 of ASME-16 and ASTM E 709. Do not use castings with defects in steel disclosed by magnetic particle test which exceed the degree permitted by Appendix 7 of ASME-16.

2.1.2.3 Acceptance Criteria

Criteria for acceptance of castings and casting repairs, including the approved welding procedure for each material used, shall be developed by the Contractor. Standards that are not definitive or that delegate discretionary authority for acceptability of castings or casting repairs to manufacturer's representatives or other individuals are not acceptable. Castings not meeting approved criteria shall be either rejected or repaired as dictated by approved standards. Repairs shall be accomplished in accordance with approved procedure and repaired areas shall be reinspected to insure completed repairs are satisfactory.

2.1.3 Bolted Connections

2.1.3.1 Bolts, Nuts, and Washers

Bolts, nuts, and washers shall conform to requirements of paragraph MATERIALS AND METALWORK FABRICATION, subparagraph DESIGNATED MATERIALS, and paragraph VERTICAL PUMPS, subparagraph PUMP COLUMN AND DISCHARGE ELBOW, subparagraph NUTS AND BOLTS for types required. Use beveled washers where bearing faces have a slope of more than 1:20 with respect to a plane normal to bolt axis.

2.1.3.2 Drill or Subdrill and Ream Holes

Drill or subdrill and ream holes for regular bolts in shop. Holes shall be accurately located, smooth, cylindrical and perpendicular to the member.

2.1.3.3 Match-ream or Drill Holes

Match-ream or drill holes for fitted bolts in shop. Holes shall be smooth, cylindrical, and perpendicular to the member. Remove burrs resulting from reaming. Bolt threads shall be entirely outside of holes.

Body diameter of bolt shall have tolerances as recommended by ASME B4.1 for class of fit specified. Selectively assemble fitted bolts in reamed holes to provide a LC-1 fit.

2.1.3.4 Holes for High-strength Bolts

Holes for high-strength bolts shall be accurately spaced, cylindrical, and perpendicular to the member. Subdrill holes and ream to full size. If thickness of material is greater than diameter of bolt, holes may be drilled full size. Poor matching of holes will be cause for rejection. Drifting done during assembly shall not distort metal or enlarge holes. For slight mismatching, reaming to a larger diameter for next standard size bolt will be allowed.

2.1.3.5 Materials Not Specifically Described

Materials not specifically described shall conform to latest ASTM specification or to other listed commercial specifications covering class or kinds of materials to be used.

2.1.4 Metalwork

2.1.4.1 Flame Cutting of Material

Flame cutting of material other than steel shall be subject to approval of Contracting Officer. Shearing shall be accurately done, and all portions of work neatly finished. Steel may be cut by mechanically guided or hand-guided torches, provided an accurate profile with a smooth surface free from cracks and notches is secured. Surfaces and edges to be welded shall be prepared in accordance with Section 3 of AWS D1.1. Chipping and/or grinding will not be required except where specified and as necessary to remove slag and sharp edges of mechanically guided or hand-guided cuts not exposed to view. Visible or exposed hand-guided cuts shall be chipped, ground, or machined to metal free of voids, discontinuities, and foreign materials.

2.1.4.2 Stress-Relieving Procedure

After all fabrication welding is completed, and prior to any machining, stress-relieve suction bell by heat treatment. Contractor shall submit proposed stress-relieving procedure for approval by Contracting Officer.

2.1.5 Machine Work

2.1.5.1 Class of Fit Required

Tolerances, allowances, and gages for metal fits between plain, nonthreaded cylindrical parts shall conform to ASME B4.1, for class of fit required.

2.1.5.2 Surface Finishes

Where surface finishes are indicated, or on Contractor's drawings, or are specified herein, symbols used or finishes specified shall be in accordance with ASME B46.1. Values of roughness height specified are the arithmetical average deviation expressed in microinches. Roughness specified is the maximum value and any lesser degree will be satisfactory unless otherwise called for on drawings. Compliance with specified surface shall be determined by sense of feel and by visual inspection of work compared to Roughness Comparison Specimens, in accordance with provisions of ASME B46.1. Values of roughness width and waviness height are not specified, but shall be consistent with general type of

finish specified by roughness height. Flaws such as scratches, ridges, holes, peaks, cracks, or checks, which will make part unsuitable for intended use, will be cause for rejection.

2.1.5.3 Unfinished Surfaces

Lay out work to secure proper matching of adjoining unfinished surfaces. Where there is a large discrepancy between adjoining unfinished surfaces, chip and grind smooth, or machine surfaces, to secure proper alignment. Unfinished surfaces shall be true to lines and dimensions shown on contract or Contractor's drawings and shall be chipped or ground free of all projections and rough spots. Depressions or holes not affecting strength or usefulness of parts shall be filled in a manner approved by Contracting Officer.

2.1.5.4 Alignment of Wetted Surfaces

Exercise care to assure that correct alignment of wetted surfaces being joined by a flanged joint is being obtained. Where plates of the water passage change thickness, transition shall occur on the outer surface, leaving inner surface properly aligned. When welding has been completed and welds have been cleaned, but prior to stress relieving, joining of plates shall be carefully checked in the presence of Government inspector for misalignment of adjoining parts. Localized misalignment between inside or wetted surfaces of an adjoining flange-connected section of pump or formed suction intake shall not exceed amount shown in Column 4 of Table 1 for the respective radius or normal distance from the theoretical flow centerline. Misalignments greater than allowable amount shall be corrected by grinding away offending metal, providing the maximum depth to which metal is to be removed does not exceed amount shown in Column 5 of Table 1. No metal shall be removed until Contractor has assured himself and Contractor Officer that no excessive stresses will occur in remaining material and that excessive local vibration will not result from removal of the material. Where required correction is greater than the amount in Column 5 of Table 1, pipe shall be rejected for use. Proposed procedure for all corrective work, other than minor grinding, shall be approved by Contracting Officer prior to start of corrective work. Corrective work shall be finished by grinding corrected surface to a smooth taper. Length of the taper along each flow line element shall be 10 times the depth of the offset error at flow line. Wetted surface irregularities that might have existed in an approved model shall not be reason for accepting comparable surface irregularities in prototype pump.

TABLE 1

(1) Pipe Diameter Inches	(2) Pipe Radius or Distance Inches	(3) Pipe Thickness Inches	(4) Maximum Offset Inches	(5) Grind-Not More Than Inches
24	12	3/8	1/16	3/32
30	15	3/8	1/16	3/32
36	18	3/8	3/32	3/32
42	21	1/2	3/32	1/8
48	24	1/2	1/8	1/8
54	27	1/2	1/8	1/8
60	30	3/4	5/32	3/16
72	36	1	5/32	3/16
84	42	1-1/8	3/16	1/4

2.1.5.5 Pinholes

Pinholes shall be bored true to gages, smooth and straight, and at right angles to axis of the member. Boring shall be done after member is securely fastened in position.

2.1.5.6 Turn or Grind All Shafting

Unless otherwise specified or authorized, turn or grind all shafting. Provide fillets where changes in section occur.

2.1.6 Welding

2.1.6.1 Welding of Steel

Unless otherwise authorized or specified, welding of steel shall be by electric arc-welding process, using a method that excludes atmosphere from molten metal. Welding of steel, unless specified otherwise, shall conform to applicable provisions of AWS D1.1.

2.1.6.2 Temporary Welds

Temporary welds required for fabrication and erection shall be made under controlled conditions prescribed herein for permanent work. Each temporary weld shall be removed after serving its purpose and ground flush with adjacent surfaces.

2.1.6.3 Casting Repairs

Castings, except those of cast iron shall have all unsound material or defects removed by chipping, machining, air-arc gouging or grinding, and shall be repaired by welding. Welding repairs shall conform to welding procedures developed and approved for the type of material involved. Stress relief annealing shall be accomplished prior to final machining.

2.1.7 Shop Assembly

Unless otherwise specified, each piece of machinery furnished, shall be assembled in the shop to determine correctness of fabrication and matching of component parts. Tolerances shall not exceed those specified or shown on Contractor's manufacturing drawings and each assembled unit shall be closely checked to ensure that all necessary clearances have been provided and that binding does not occur in any moving part. Assembly in shop shall be in the same position as final installation in the field unless otherwise specified. Perform assembly and disassembly work in the presence of a Government representative, unless waived in writing by Contracting Officer, and immediately remedy errors or defects disclosed without cost to Government. Before disassembly for shipment, matchmark each piece of a machine or structure to facilitate erection in the field. Indicate location of matchmarks by circling with a ring of white paint after the shop coat of paint has been applied, or as otherwise directed.

2.2 VERTICAL PUMPS

2.2.1 Speed

Rotative speed of pump shall be no greater than 275 rpm and tip speed of impeller shall be no greater than 75 feet per second. Verify that rotative speed of pump at which the NPSH is produced is no less than required, as determined by cavitation tests specified in paragraph FACTORY TEST.

2.2.2 Reverse Flow

Pump shall withstand, with no damage, the full force exerted on it, with impeller subjected to reverse flow and upper end locked in place by backstop. Calculate head to determine the force developed by this reverse flow from specified highest discharge side water elevation and lowest pump intake side water elevation. Reverse rotative speed shall be 0.0 with instantaneous activation of backstop.

2.2.3 Efficiency

Efficiency at design condition specified in paragraph CAPACITIES shall not be less than 80 percent.

$$\text{Efficiency} = \frac{Q \times H}{3960 \times \text{BHP}} \times 100$$

Where: Q = Discharge, gallons per minute

H = Total head, feet

BHP = Pump brake horsepower

2.2.4 Impeller Bowl

Make impeller bowl of either cast iron, cast steel, welded steel plate or a combination of cast steel and steel plate. Steel plate, if used, shall have thickness of not less than 3/4 inch after machining is completed. Welds shall be heat-treated stress-relieved before final machining. Provide flanges for mating with formed suction intake and impeller bowl or two-piece construction of impeller. Flanged connections with FSI shall be provided with a rabbet fit or four equally spaced dowels installed in the vertical position for initial alignment purposes and to maintain concentric alignment of pump. Machine finish impeller-swept area in impeller bowl to at least 125 rms and concentric with impeller axis. For mixed-flow impellers, angle in impeller bowl shall equal the outside angle of impeller blade tips. Tolerance for concentricity of impeller with the impeller axis shall not be greater than 20 percent of the operating clearance between impeller and impeller bowl.

2.2.5 Diffuser Bowl

Make diffuser bowl of cast iron, cast steel, welded steel plate, or a combination of cast steel and steel plate. Steel plate, if used, shall have thickness of not less than 3/4 inch after machining is completed. Diffuser shall contain support for upper impeller shaft bearing and have vanes to guide the pumped flow. Equip diffuser bowl with a bypass drain to outside of pump from the diffuser cavity located between the enclosing tube connection and impeller. Furnish throttle bushing located in the cavity immediately above impeller. Bypass drain and throttle bushing should be designed to reduce water pressure on lower seal. Impeller back-wear rings can also be used to reduce water pressure on lower seal.

2.2.6 Pump Column and Discharge Elbow

2.2.6.1 Column and Discharge Elbow

Make column and discharge elbow of either cast iron, cast steel, or welded steel plate. Steel plate, if used, shall have thickness of not less than 3/4 inch after machining is completed. Elbow shall be of mitered type. Turning vanes, if used, shall be spaced apart at least twice the space of clear space of trashrack. Column and discharge elbow shall be designed to withstand internal pressures and external loadings associated with various conditions of pump operation. Provide flanges for mating individual segments together and for mating pump column to diffuser bowl. Flanges shall have rabbeted fits or four equally spaced dowels installed in flanges for initial alignment purposes and to maintain concentric alignment. The elbow shall terminate in a plain-end circular section. Diameter tolerance of plain end shall be plus 0.12/minus 0.06 inch. Diameter of discharge end of elbow shall be as shown and shall allow standard diameter flexible couplings to be used. Adjustable thrust rods and thrust lugs shall be used to transfer the load by bridging the coupling.

2.2.6.2 Column and Discharge Elbow Support

Design pumping unit for installation as shown. Pump casing shall be supported at lower floor, EL 264.0. Furnish support system. Support system shall transfer entire load on baseplate to lower floor. Design support system to maintain proper alignment of pumping unit and propeller blade setting. Include support system in the dynamic analysis.

2.2.6.3 Pumps Discharge Diameter

Pumps having discharge diameter greater than 60 inches shall contain a manhole. Structural steel bracket with a platform of raised-pattern floor plate similar to the one(s) shown on contract drawings shall be provided as a support for maintenance personnel for access to pump through a manhole. Provide manhole 24 inches x 30 inches, or largest practicable size with gasketed cover, in the column above diffuser bowl. Provide jack bolts in cover together with eye bolts to facilitate removal.

2.2.6.4 Formed Suction Intake (FSI)

- a. Provide FSI water passage with pump, sized to fit within limiting elevations and dimensions shown. No bearing shall be located below the impeller when FSI is used.
- b. Dimensions of intake elbow and conical transition section of FSI are relative to diameter at the top of cone, as defined on drawings. Diameter at top of cone and related dimensions are determined to accommodate the size of pump, providing limiting values for discharge and submergence are not exceeded, floor of the FSI remains at elevation 264.00, and impeller datum is set no higher than elevation 276.00. Rectangular transition section of the FSI upstream of elbow can be modified in length to match width of individual pump bay or sump intake. Modification shall be limited to surfaces and dimensions indicated on drawing, and shall be approved by Contracting Officer.
- c. Construct FSI of fabricated steel, cast steel, or a combination of these materials embedded in concrete. Stiffeners used shall be on outside of the FSI to allow smooth flows in the FSI. Size subassemblies of the FSI, unless constructed of formed concrete, to permit placement through sump gate and trashrack. Bolts used to connect flanges shall be stainless steel with bronze nuts. Minimum thickness of fabricated material shall be 3/4 inch for fabricated portions. Provide grout holes in floor of the FSI to permit full grouting.

- d. FSI connection to pump impeller bowl flange shall be designed by the pump manufacturer and be rigid or flexible as indicated by results of the dynamic analysis required in paragraph DYNAMIC ANALYSIS. Submit design and drawings indicating materials of construction and method of assembly of the FSI to Contracting Officer for approval.

2.2.6.5 Flanges

Machine flanges and drill bolt holes concentric with pump shaft vertical centerline, having tolerance of plus or minus one fourth of clearance between bolt and bolt hole. When fabricated from steel plate, flanges shall not be less than 2 inches thick after machining. Flange thickness after machining shall not vary more than 10 percent of greatest flange thickness. Provide external stiffeners, if needed. Construct fabricated flanges, as a minimum, to the dimensions of AWWA C207, Class B. Flanges on major components of pump casing (impeller bowl, diffuser bowl, and column and elbow piping) shall be designed such that blindholes necessitating use of cap screws or stud bolts will not be used. Design flanges for connection to column pipe by at least two continuous fillet welds. One weld shall connect inside diameter of flange to pump column and the other shall connect outside diameter of pump column to flange. Final design of welds rests with manufacturer, and specified welds are the minimum requirement. They shall be parallel machined, when provided on each end of the same component, and mounted parallel to a plane that is normal to pump shaft centerline. Flanges on each end of the same component shall have parallel tolerance of 0.002 inch. Finish machine mating surface on flange to 125-microinch finish or better. Provide flanges with minimum of three jacking bolts to aid in disassembly of pump.

2.2.6.6 Flanged Joints

Design flanged joints to be air-and water-tight, without the use of preformed gaskets, against positive and negative operating pressures that will be experienced, except that "PERMATEx" or equal gasketing compound will be permitted. Provide mating flanges, unless of the male-female rabbit type, with not less than four tapered dowels equally spaced around flange. If rabbeted fit is not used, then Contractor shall provide the method used to determine concentricity of connected pieces.

2.2.6.7 Nuts and Bolts

Bolts used in assembling pump and its supporting members, including anchor bolts and dowels, shall be of 300 series stainless steel. Use only bronze nuts and hexagonal bolts and nuts. Washers used shall be 300 series of stainless steel.

2.2.6.8 Galvanic Protection

When dissimilar metals are used, use zinc anodes. Provide machined mounting pads and install anodes on carbon steel or cast iron parts. Fasten anodes to bare material on pump so that continuity is obtained between anode and pump. Verify continuity by checking joint with an ohmmeter. Locate anodes on exterior of pump below normal sump level. Total weight of anodes used per pump shall be 150 pounds. Pump joints shall be electrically bonded at the joints.

2.2.6.9 Harnessed Coupling

Provide flexible mechanical coupling connecting pump discharge elbow to wall thimble equal to Dresser style 38 coupling or approved equal. Finish middle ring without pipe stop to facilitate installation and removal of coupling.

2.2.6.10 Wall Thimble

Wall thimble shall have one plain end to accommodate flexible mechanical coupling and one flanged end to mate with flap valve. Plain end shall match pump discharge elbow in thickness and diameter and flanged end shall be drilled to match, and shall be capable of supporting without distortion, the flap valve. Provide seal ring on wall thimble located so that it is centered in the wall when embedded. Fabricate wall thimble from steel plates.

2.2.7 Impeller

Make impeller hub and blades of cast steel equivalent to 316 stainless. Brinell hardness shall be a minimum of 200 and tensile strength shall be 30,000 psi minimum. They may be cast separately or together as a single unit. If cast separately, attach blades to hub in a manner that ensures them against loosening in service but that does not necessitate any damage during disassembly. Welding of blades to hub is acceptable. If this method of attachment is used, Contractor shall submit welding procedure to be used.

2.2.7.1 Casting Inspections

After removal from mold, and prior to finishing of surface imperfections, castings shall be inspected by Contracting Officer. Minor surface imperfections shall be filled or ground down as necessary to preserve correct contour and outline of impeller and to restore surface imperfections to the same degree of finish as surrounding surfaces. Correct surface pits, depressions, projections, or overlaps showing greater than 1/16 inch variation from the general contour for that section. Castings that exhibit surface imperfections (as defined above) covering an area of more than 10 percent of blade surface will be rejected.

2.2.7.2 Impeller Balancing

Statically balance finished impeller to within 12 oz-in of unbalance. Then dynamically balance impeller by the two-plane balancing technique. Impeller shall be balanced at rated operating speed. Check balance at 110 percent of balance speed, and make needed corrections. Amount of allowable unbalance shall be in accordance with ASA S2.19. Weights needed to obtain required level of balance shall be securely fastened to inside cavity of impeller hub. In no case will portions of the impeller be removed or weights be added to outside of hub, vanes, or water passages. Submit balancing procedure to Contracting Officer for approval at least four weeks prior to date of balancing. Each finished impeller shall be weighed and weight stamped on the bottom of hub. Weight shall be accurate to 0.5 percent of the total weight of impeller. Weighing and balancing shall be witnessed by Contracting Officer.

2.2.8 Shafts

2.2.8.1 Impeller Shaft

Impeller shaft shall be stainless steel and intermediate shaft(s) shall be cold-rolled carbon steel. Design shafting so that any necessary vertical adjustment of impeller can be made from operating room floor without interfering with shaft alignment. Design shafts based on criteria set forth in ASME B106.1M for two different design cases. The first uses a factor of safety of 5 based on ultimate tensile strength of shaft material and rated horsepower of motor. The second uses 75 percent of the yield strength of shaft material and locked rotor torque of motor.

2.2.8.2 Pump and Gear Reducer Shafts

Pump and gear reducer shafts shall be coupled together using rigid flanged coupling capable of transmitting the forces and torques involved. Coupling halves shall be bolted together and shall be maintained concentric with each other, by means of a rabbet fit, to within 0.002 inch. Shaft coupling nut, if used, shall be retained by fitted bolts, and all tolerances specified for the coupling shall apply. Finish machine the flange and bore in one setup to insure that flange of coupling shall be true to the bore. Flange shall be perpendicular to the bore, and parallel to the opposite end and mating flanges to within 0.002 inch. Flange shall be concentric to centerline of shaft to within 0.002 inch. The finished shaft assembly shall be concentric about shaft centerline to within 0.004 inch. Shop assemble couplings and pump shaft and inspect for compliance with contract requirements. After inspection, matchmark parts, including fitted bolts, to their mating pieces.

2.2.8.3 Removable and Renewable One-piece Journals

Provide stainless steel removable and renewable one-piece journals at each bearing and the packing gland. Securely fasten journals to shaft to prevent shifting. Keys and fasteners, if used, shall be made from corrosion-resisting steel. Fastening of journal sleeves to shaft by welding or by adhesives will not be permitted. Shaft finishes/construction at lower seal locations shall be as specified in paragraph VERTICAL PUMPS, subparagraph GUIDE BEARINGS, subparagraph GREASE LUBRICATION SHAFT SEALS.

2.2.9 Shaft Enclosure

Provide shaft enclosure to cover intermediate shaft and coupling. It shall be rigid enough to be self-supporting. External supports or bracing located in pump water passage shall not be used for support of the enclosing tube unless necessary to support intermediate bearings or indicated to be necessary or advantageous by dynamic analysis required in paragraph DYNAMIC ANALYSIS. Consider effect of external supports, including rubber inserts, in the dynamic analysis required in paragraph TEST, INSPECTIONS, AND VERIFICATIONS, subparagraph DYNAMIC ANALYSIS. Design enclosure to be watertight and for easy assembly and disassembly in the field. Enclosing tubes constructed with screw type joints and using tension in tube to hold alignment, shall be constructed to prohibit tension tube from unscrewing when packing gland adjustments are made. Provide shaft enclosure for grease-lubricated pumps with a drain having a shut-off valve located outside of the pump to permit draining enclosure between operation periods. Locate drain at bottom of shaft enclosure.

2.2.10 Lifting Lugs

Furnish major pump components with lifting lugs or eye bolts to facilitate handling. Design and arrange lugs or bolts to allow safe handling of pump components singly or collectively as required during shipping, installation, and maintenance.

2.2.11 Guide Bearings

2.2.11.1 General

Provide pump with sleeve-type bearings designed for grease lubrication. Bearing shall have a bronze lining in contact with shaft journal and shall be removable and renewable type. Arrange bearing liner for maximum distribution of grease for lubrication of journal surface. Bearings shall have a surface finish of 32 rms or better. Since pumped water may contain some fine sand and silt in suspension, give

special attention to the design and selection of bearing parts, especially seal rings, to preclude entrance of foreign material between bearing and journal or journal sleeve and shaft due to differential water pressure.

2.2.11.2 Grease Lubrication Shaft Seals

Pumps designed for grease lubrication shall have a shaft seal consisting of lip seals. Seal system shall consist of a lip-type seal located on each end of bearing. Each seal shall contain a lip element having a stainless steel garter spring back-up and be constructed of TFE (Teflon). Lip element shall face bearing. Lowest bearing shall have an additional grease seat with lip facing away from bearing. Grind shaft to finish of 16 rms at seal location. Shaft surface under seal area shall have a hardness as recommended by seal manufacturer or shall be fitted with a replaceable stainless steel sleeve of manufacturer's recommended hardness. Use bullet-shaped assembly tool or other special tools over the end of shaft and shaft grooves to preclude damage to lip element during assembly. Assembly tool used is considered a special tool and shall be furnished to Government as part of special tools specified in paragraph MAINTENANCE, subparagraph SPECIAL TOOLS.

2.2.12 Bearing Heat Sensors

Fit each bearing with 100 ohm platinum RTD temperature-sensing elements, inserted in bearings to within 1/8 inch of shaft. These temperature-sensing elements shall be provided with temperature readouts mounted at a central location as shown. Provide visual and audible alarm system to warn of bearing overheating. Support leads and protect from water and mechanical damage. Terminate leads outside of pump casing in an approved waterproof junction box and cap until final connections are made in the field. Lead protection shall consist of pipes fastened to pump with brackets using bolts and nuts to permit their removal, and shall be constructed with enough unions to be completely disassembled. Leads passing through pump water passage in pump shall either be contained in a guide vane or be protected by schedule-120 pipe. Protection pipe shall be removable if connected to shaft-enclosing tube. Install bearing heat sensors as shown in Figure 2 at end of the section. Run leads and wiring to a junction box located on baseplate. Provide terminal strip in junction box for connection of wiring to temperature readouts.

2.2.13 Thrust Bearing

Provide thrust bearing to carry total thrust load with speed reduction gear as specified in Section 11212 SPEED REDUCERS FOR STORM WATER PUMPS.

2.2.14 Packing Gland

Provide grease-lubricated packing gland split longitudinally to facilitate removal or renewal. Arrange it to permit inspection, repair, removal, or replacement of packing without entering pump from below operating room floor. Provide eye bolts and tapped holes in each half of the split gland if halves weigh over 30 pounds each.

2.3 LUBRICATION SYSTEM

Support grease lines to each bearing and protect from water and mechanical damage. Grease line protection shall consist of channels fastened to pump with brackets, using bolts and nuts to permit removal. Grease lines passing through pump water passage shall either be contained in a guide vane or be protected by schedule-120 pipe. This protection pipe shall be removable if connected to shaft-

enclosing tube. Prefill grease lines before connection to bearings. Terminate grease lines above baseplate for connection to lubricating grease pump.

2.3.1 Centralized Pressure Lubrication System

2.3.1.1 General

Provide each pump with its own individual electric motor-driven centralized pressure lubrication system, designed to deliver the proper predetermined or metered quantity of lubricant to each individual bearing and stuffing box. It shall positively indicate proper or improper functioning of any individual metering device. Mount pressure pump, individual metering devices, and any required auxiliary operating accessories suitably on baseplate. System shall be furnished complete and ready for operation, including sufficient lubricant to fill each pressure pump lubricant reservoir. Submit complete centralized pressure lubrication system to Contracting Officer for review and approval. Furnish lubricant recommended by pump manufacturer, subject to approval of Contracting Officer.

2.3.1.2 Pumping Unit

Provide electric motor-driven central pumping unit as a complete assembly, consisting of positive displacement type pump, flow-directing valve (if required), lubricant reservoir, suitable pressure gage to indicate pump discharge pressure, operation counter, pressure protective device, and other auxiliary accessories as required to give a complete and workable unit conforming to requirements specified. Pump shall be of multiple individual piston, positive displacement type utilizing hardened steel pistons closely fitted to cylinder bores to eliminate the need for packing, and spring-actuated check valves shall not be required for its operation. Pump shall deliver not less than 6 cubic inches of lubricant per minute against a pressure of not less than 2,000 pounds per square inch measured at the most remote bearing connection. Lubricant reservoir shall be of suitable metallic construction, shall have a capacity of not less than 24 pounds of lubricant, shall be provided with suitable means that will ensure positive priming of pump at all times (such as an atmospheric or spring-loaded follower plate), an indicator to show quantity of lubricant in reservoir, and a screened fill connection to permit filling reservoir by transfer pump without exposing lubricant to atmosphere. Provide pump unit with a fully automatic control system, capable of suitable or proper scheduling by an adjustable synchronous motor-driven timing device, and other required auxiliaries necessary to give a complete and workable system. Provide controller with a "Hand Off-Automatic" selector master switch to permit selection between push button manual and automatic time clock operation, and to deenergize the system. Electric power will be supplied at 115 volts single phase, 60 cycles. Use time clock setting recommended by main pump manufacturer.

2.3.1.3 Metering Valves

Provide metering or measuring valve for each bearing and stuffing box. It shall be fully hydraulic in its operation, requiring no internal springs or check valves. Valve for any given lubricated device shall have sufficient capacity to deliver a maximum quantity of lubricant equal to approximately one third of nominal clearance volume of bearing or gland served each time measuring valve is discharged or system is cycled.

2.3.1.4 Piping

System piping shall be stainless steel tubing (ASTM A 268, Type 410 or equal) using flared or compression-type connectors. Adequately protect and rigidly support piping located below operating room floor in a manner approved by Contracting Officer. Provide each individual grease line with a

"Tee" fitting, located immediately below the respective metering valve and accessible from operating room. Also provide with a standard 1/4-inch grease fitting so that each individual line may be fully charged without using pump of lubricating system. Size and strength of pipe and type and strength of fittings shall be as recommended and guaranteed by lubrication system manufacturer, but in no case shall bursting pressure of pipe or tubing used be less than three times the maximum working pressure. Provide check valve located between discharge outlet of the measuring valve and "Tee" fitting specified above in each lubricating line of bearings that is exposed to water pressure to prevent entrance of water into the respective measuring valves.

2.3.2 Lubrication System Accessories

2.3.2.1 Grease Gun

A hand operated, heavy duty lever grease gun for charging lubrication lines and for emergency lubrication shall be provided. Provide grease as recommended by the vertical pump manufacturer.

2.3.2.2 Service Facilities

A service facility consisting of a portable hand operated transfer pump, a hand-towed dolly, and a 120 pound drum of lubricant, all assembled and ready for operation shall be provided. The pump shall be self-contained and designed for mounting on the grease drum to protect the contents from the entrance of foreign matter. The pump shall deliver not less than one pound in not more than eight strokes of the pump handle under normal temperature conditions. Furnish necessary hose and quick disconnect coupling for a complete system. The hand-towed dolly shall have a rigid platform with four anti-friction bearing mounted wheels, a towing handle and a provision for securing the lubricant barrel. The type of lubricant shall be as recommended by the vertical pump manufacturer.

2.4 FACTORY FINISHING

2.4.1 Painting

Painting shall be in accordance with Sections 09940 PAINT: HYDRAULIC STRUCTURES.

2.5 TESTS, INSPECTIONS, AND VERIFICATIONS

2.5.1 Dynamic Analysis

Before pump and motor are released for manufacture, pump/motor structure shall be analyzed by pump manufacturer for harmful natural frequencies in the lateral and torsional directions. A natural frequency that occurs within 25 percent above or below normal operating speed is unacceptable. Dynamic analysis model shall be constructed using a commercially available program such as Ansys, Cosmos/M, or equivalent, which utilize finite element methods. Incorporate effects of column pipes, cover pipes, shafts, bearings, mass concentrations, and other such features as necessary to accurately model pump structure. Analyze structure in the run (wet) condition and consider the effect of water mass in the column and damping effect of water in the sump (vertical units only) at highest and lowest sump water levels. Incorporate Reed critical frequency and mass elastic diagram information provided by motor manufacturer. If motor manufacturer cannot demonstrate to the satisfaction of Contracting Officer (based on impact tests of similar units) that the Reed critical frequency value is accurate, motor manufacturer shall conduct a dynamic analysis using finite element methods as described to determine motor Reed critical frequency for use by pump manufacturer. Submit complete dynamic analysis report including the following information:

- a. Computer program used.
- b. Schematic diagram of the model depicting nodes and elements.
- c. Input data consisting of node coordinates, element types, material properties, element characteristics, element connectivities, and specified displacements.
- d. Motor mass elastic and Reed critical information (or dynamic analysis, if required).
- e. Analysis results, including significant natural frequencies.
- f. Interpretation of results.

Impact test motor furnished before shipment to determine actual Reed critical frequency of motor. Include results of impact tests included in motor test data to be submitted. Pump manufacturer shall address any discrepancy between calculated and actual motor Reed critical frequency values to determine whether design changes are required to prevent harmful natural frequencies in the pump/motor structure. If any design changes are required, these shall be incorporated at no cost to Government.

2.5.1.1 Torsional Analysis

Before pump, gear drive, and engine are released for manufacture, engine supplier shall analyze the system for harmful torsional natural frequencies using mass elastic information provided by pump and gear drive manufacturers. A natural frequency that occurs within 25 percent above or below normal operating speed is considered to be unacceptable.

2.5.1.2 Lateral Frequency Analysis

Before pump, gear drive, and motor is furnished under Section(s) 15170 ELECTRIC MOTORS, 3-PHASE HORIZONTAL INDUCTION TYPE and 11212 SPEED REDUCERS FOR STORM WATER PUMPS, respectively, are released for manufacture, pump/gear drive structure shall be analyzed by pump manufacturer for harmful natural frequencies in the lateral directions. A natural frequency that occurs within 25 percent above or below any operating speeds required for pump operating conditions is considered to be harmful. The dynamic analysis model shall be constructed using a commercially available program such as Ansys, Cosmos/M, or equivalent that utilizes finite element methods. The model shall incorporate effects of column pipes, cover pipes, shafts, bearings, mass concentrations, and other such features as necessary to accurately model pump structure. Analyze structure in the run (wet) condition and consider the effect of water mass in the column and the damping effect of water in the sump at highest and lowest sump water levels. The model shall incorporate Reed critical frequency and mass elastic diagram information provided by gear drive manufacturer. If gear drive manufacturer cannot demonstrate to the satisfaction of Contracting Officer (based on impact tests of similar units) that the Reed critical frequency value is accurate, a dynamic analysis using finite element methods as described herein shall be conducted by gear drive manufacturer to determine gear drive Reed critical frequency for use by pump manufacturer. Submit complete dynamic analysis report including the following information:

- a. Computer program used.
- b. Schematic diagram of the model depicting nodes and elements.

- c. Input data consisting of node coordinates, element types, material properties, element characteristics, element connectivities, and specified displacements.
- d. Gear mass elastic and Reed critical information(or dynamic analysis, if required).
- e. Analysis results including all significant natural frequencies.
- f. Interpretation of results.

Impact-test gear drive before shipment to determine the actual Reed critical frequency of the drive. Submit results of impact tests. Pump manufacturer shall address any discrepancy between calculated and actual gear drive Reed critical frequency values as to whether or not design changes are required to prevent harmful natural frequencies in pump/gear drive structure. If any design changes are required, these shall be incorporated at no cost to Government.

2.5.2 Lubricating System Tests

Test complete lubricating system for each pumping unit, as deemed necessary by Contracting Officer, to determine that system meets operational requirements specified. At least one valve of each size furnished shall be tested with the lubrication line removed from its bearing and fitted with a pressure relief valve and pressure gage. The pressure relief valve shall be adjusted to discharge it at the operating pressure specified and the system shall be operated through one or more cycles as required to obtain an accurate measurement of the quantity of lubricant delivered, which shall be within plus or minus 20 percent of the theoretical delivery of the respective valve. Any component parts that are damaged as the result of these tests or that fail to meet the requirements of the specification shall be replaced, reinstalled, and retested at the Contractor's expense.

2.5.3 Factory Test

2.5.3.1 General

The performances and cavitation limits of the prototype pump shall be determined by a series of tests made on a scale model of the pump. The model test shall be completed within 180 days after date of notice to proceed.

2.5.3.2 Test Setup

- a. Model Pump - The model pump shall be homologous to the proposed prototype pump, and mounted with the shaft in the vertical position. The inlet diameter shall be not less than 11 inches. The complete FSI, including metal and concrete section to head wall, shall be included in the model test. The FSI used in the model test shall be geometrically the same as that used for the prototype.

2.5.3.3 Instrumentation and Procedures

Each instrument shall be described in detail, giving all data applicable, such as the manufacturer's name, type, model number, the certified accuracy, coefficient, ratios, specific gravity of manometer fluid to be used, and smallest scale division. When necessary for clarity, a sketch of the instrument or instrument arrangement shall be included. Also included therein shall be a fully detailed narrative description of each proposed method of instrumentation and of the procedures to be used.

- a. Head Measurements - Head measurements shall be made using either a direct-reading water column, a mercury-air or mercury-water manometer, or a pressure transducer. Vacuums shall be measured with either a mercury-air or mercury-water manometer or a pressure transducer. Fluctuations shall be dampened sufficiently to permit the column gages and transducers to be read to either the closest one-hundredth (.01) of 1 foot of water or one-tenth (.1) of 1 inch of mercury. When pressure transducers are used, their accuracy shall be checked with a manometer.
- b. Capacity - Model pump capacity shall be determined by a calibrated venturi flowmeter or a long-radius ASME flow nozzle. The venturi or nozzle taps shall be connected to column gages or a differential pressure transducer equipped with dampening devices that will permit the differential head to be determined to either the closest one-hundredth (.01) of 1 foot of water or one-tenth (.1) of 1 inch of mercury. Magnetic flowmeters and flowmeters utilizing sonic flow measurement will be acceptable, if calibration of flow-meters has been completed within the last 6 months.
- c. Rotational Speed of Pump - The rotational speed of the model pump shall be measured in accordance with HI-01, except that revolution counters shall not be used. Non-contacting hand-held electronic tachometers are acceptable. Device used shall permit speed to be determined to 1 rpm.
- d. Power Input - Measure power input to pump in accordance with "Power Measurements" in HI-01. Use a method to permit pump brake horsepower to be determined to the closest 0.5 horsepower.
- e. Cavitation Tests - The instruments to be used for these tests shall be selected by the Contractor and shall be of the type suited for cavitation testing. However, in no case shall the instruments used yield results less accurate than those obtained with the performance test.

2.5.3.4 Pump Test

Test shall demonstrate that proposed pump operates without instability and complies with specified performance. Instability is defined when any point in usable range of the head-capacity curve cannot be repeated within 3 percent or when a test point deviates from the normal curve by 2 percent. When this occurs, rerun test. Compliance with specifications will be determined from curves required by paragraph TEST RESULTS. Test procedures, except as herein specified, shall be in accordance with applicable provisions of HI-01. Temperature of water used for testing shall be approximately the same for all tests run and shall be recorded during test runs.

- a. Performance of The Prototype Pump - The performance of the prototype pump shall be determined by a series of test points sufficient in number to develop a constant-speed curve over the range of total heads corresponding to the static heads in paragraph CAPACITIES. The performance/test range shall include additional testing at total heads 2 feet higher than the total head determined in paragraph CAPACITIES. The lowest total head for testing shall be, as a minimum, the total head determined from paragraph CAPACITIES. If the test setup permits testing at lower total heads, the range of total heads shall be extended 2 feet lower. Testing shall be inclusive at the rated speed of the pump with the sump at elevation 278.0. Tests shall be made using prototype total heads. Head differentials between adjacent test points shall not exceed 3 feet. If the plot of the data indicates a

possibility of instability or dip in the head-versus-capacity curve, a sufficient number of additional points on either side of instability shall be made to clearly define the head-capacity characteristics. For compliance with the guarantees, the efficiency of the prototype pump shall be considered to be the efficiency of the model. No other computation or adjustment of model efficiency to prototype conditions will be permitted unless expressly permitted elsewhere in these specifications.

- b. Sump Elevations - Conduct tests at two different sump elevations (of approximately 5-foot differential) to determine the effect of test sump geometry on performance of pump. Should test results indicate that performance is not the same in all respects for both sump conditions, Contractor shall take whatever corrective action is necessary to produce congruent results. Sump elevations used shall be those specified in paragraph CAPACITIES. Test results with this sump elevation shall meet all specified conditions of capacity, head, and brake horsepower. Submit curves indicating test results to Contracting Officer.
- c. Tests Results - Plot results of tests to show total head, static heads, brake horsepower and efficiency as ordinates; all plotted against pump discharge in gallons per minute as the abscissa. Plot curves showing prototype performance to a scale that will permit reading head directly to .5 foot, capacity to 500 gallons per minute, 50 cubic feet per second, efficiency to 1 percent, and power input to 25 horsepower.

2.5.3.5 Demonstration

Contractor shall demonstrate to Government witness that the blade templates fit the tested pump. Demonstration shall be done immediately after performance testing is completed. Contractor shall retain all templates for the accepted pump model and for the prototype, and shall furnish them to Government upon request of Contracting Officer, to permit Government to verify that the prototype pump is in complete geometric similarity with the model. In lieu of providing templates, furnish dimensioned drawings of impeller, which contain all dimensions needed to manufacture impeller. Retain model pump impeller used for the test until final acceptance of prototype pump. Model impeller shall be stamped with identification marks. Contractor shall retain all templates for components of the tested model or prototype pump, or both, and shall furnish them to Government upon request of Contracting Officer, along with the necessary facilities and instruments needed to permit Government to verify that prototype pump(s) is in complete geometric similarity with the model pump or tested pump.

2.5.3.6 Cavitation Tests

- a. Model Test - The model test shall include the determination of net positive suction head required (NPSHR) at five or more points on the constant speed curve. NPSHR shall, as a minimum, be determined for five or more capacities corresponding to prototype capacities over the total range of specified operating conditions. If the pump has a capacity greater than that specified for the lowest and/or highest operating condition, then these over-capacity conditions shall be used. The other test capacity points shall be equally spaced between the highest and lowest capacities.
- b. NPSHR - NPSHR shall be determined on a constant-capacity, constant-speed basis, using an arrangement similar to that described under paragraph "Cavitation Tests" for vertical pumps in the test code section of "Centrifugal Pumps" in HI-01. Suction conditions shall be varied to produce cavitation. NPSHR shall be the maximum value at which any one or

all of the plotted curves, head, horsepower, and efficiency depart from the constant values (point of tangency). A sufficient number of points to accurately locate the departure point shall be obtained.

- c. Value of NPSHR - The value of NPSHR shall be 1 foot less than the corresponding available net positive suction head (NPSHA). NPSHA shall be determined using the temperature of the water in the model at the time the tests are run and the datum shown on Figure 3 at the end of this section. The water elevations specified in paragraph CAPACITIES shall be used to determine the NPSHA for the pumps.
- d. Plotting Test Results - The test results shall be plotted to the scales determined by the Contracting Officer at the time of the test. Curves showing static head, brake horsepower, and efficiency as ordinates and NPSH as the abscissa shall be drawn. In addition, curves showing NPSHR versus capacity shall be drawn with NPSH as the ordinate and capacity as the abscissa. NPSHA points shall be shown on the curves.
- e. Curves - Should it be considered necessary by the Contractor to take into account measurement inaccuracies when drawing the curve needed to determine NPSHR in accordance with paragraph NPSHR, the following method shall be used. No other method will be acceptable. The inaccuracy shall be determined by the Contractor for each parameter, and the calculations shall be furnished to the Contracting Officer for approval. Using the calculated inaccuracy as the radius and the test point as the center, a circle shall be drawn for each test point. Two curves, one a maximum and the other a minimum, shall be drawn and shall pass through or touch each circle. The maximum curve shall touch the top and the minimum curve shall touch the bottom of as many circles as is practicable while maintaining smooth curves. Should the plot indicate that a test point is obviously erroneous, it may be ignored by mutual consent or the test may be rerun. Halfway between the maximum and minimum curves, another curve (the mean) shall be drawn. The point at which the mean curve departs from the constant values (point of tangency) shall be considered to be the NPSHR of the pump for the capacity at which the test was run.

2.5.3.7 Blade Templates Demonstration

The Contractor shall demonstrate to the Government witness that the blade templates fit the tested pump. The demonstration shall be done immediately after the performance/cavitation testing is completed. The Contractor shall retain all templates for the accepted pump model and for the prototype, and shall furnish them to the Government upon request of the Contracting Officer, to permit the Government to verify that the prototype pump is in complete geometric similarity with the model. In lieu of providing templates, the Contractor shall furnish dimensioned drawings of the impeller that contain all dimensions needed to manufacture the impeller. The Contractor shall retain the model pump impeller used for the test until final acceptance of the prototype pump. The model impeller shall be stamped with identification marks. The Contractor shall retain all templates for the components of the tested model or prototype pump, or both, and shall furnish them to the Government upon request of the Contracting Officer along with the necessary facilities and instruments needed to permit the Government to verify that the prototype pump(s) is in complete geometric similarity with the model pump or the tested pump.

2.5.3.8 Witness Test

When Contractor is satisfied that model performs in accordance with specification (and guaranteed values), he shall notify Contracting Officer that witness tests are ready to be run and furnish him two

copies of curves, along with a set of sample calculations including all constants and conversion factors. Four weeks will be required to review these data before Contracting Officer will be available to visit Contractor's laboratory for witnessing test. Should the witness test reveal that the model does not perform in accordance with specification, Contractor shall make such changes as are required to make the model acceptable before again notifying Contracting Officer that witness tests are ready to be run. Immediately upon completion of each witness test, copies of all data taken, computations of test results, and plotted curves shall be furnished to the witness.

2.5.3.9 Test Report

Submit, within 30 days of receipt of approval of the witness test, to Government 4 bound copies of a report covering completely test setup and performance tests. Each test report shall include, as a minimum, the following:

- a. Statement of the purpose of test, name of project, contract number, and design conditions should be given. Where guaranteed values differ from specified values, they also should be given.
- b. A resume of preliminary studies, if such studies were made.
- c. Description of pump, gear reducer, and motor, including serial numbers, if available. Information required under "b" may be included here.
- d. Description of test procedure used, including dates, test personnel, any retest events, and witness test data.
- e. List of all test instruments with model numbers and serial numbers.
- f. Sample computations (complete).
- g. A discussion of test results.
- h. Conclusions.
- i. Photographic evidence in the form of either 24 color photographs of test equipment, test setup and representative test segments, or a VHS videotape, at least 30 minutes in length, covering the same information as photographs. All photographic evidence should be labeled with contract number, location, date/time, and test activity. Videotape shall be voice annotated with the same information.
- j. Copies of instrument calibration.
- k. Copies of all recorded test data.
- l. Curves required by paragraph TESTS RESULTS.
- m. Curves showing the performance of the model and/or prototype pump.
- n. Drawings of the test setup showing all pertinent dimensions and elevations and a detailed dimensioned cross section of the pump.

2.6 BASEPLATE AND SUPPORTS

The baseplate located at pump station elevation 274.0 shall be proportioned to support the entire pump assembly, the reduction gear and the loads (including the results of the dynamic analysis) to which it may be subjected during operation. It shall be supported and anchored as shown on the drawings and as designed by the manufacturer for the particular installation taking into account all operational and seismic loads. Lifting lugs or eye bolts, special slings, strongbacks, or other devices necessary to handle the pump during loading, unloading, erection, installation, and subsequent disassembly and assembly shall be furnished. A sole plate shall be provided under the baseplate. Jacking bolts shall be provided for leveling the baseplate assembly. An anchor bolt layout shall be provided to aid in placement of anchor bolts. All leveling jacking bolts shall be backed off after grouting so that they do not support any of the load. The pedestal supporting the right-angle reduction gear shall contain a 1-inch lip to contain water leakage from the shaft packing. A threaded drain to the sump shall be provided.

2.7 FREEZE PROTECTION

All parts of the pump shall have drain holes to eliminate trapped water that could freeze. These drain provisions shall be self-draining without any requirement to enter the sump.

2.8 FACTORY ASSEMBLY

The pump shall be assembled at the manufacturer's plant to assure proper fitting and alignment of all parts. The FSI, impeller housing, diffuser, and the discharge elbow shall be properly match marked and have their centerlines clearly marked on the outside of all flanges to facilitate erection and alignment in the field. The Contractor shall notify the Contracting Officer sufficiently in advance to permit a representative of the Contracting Officer to inspect and witness the pump assembly. All parts disassembled for shipment shall be matchmarked.

2.9 NAMEPLATE

The pump shall be identified by means of a separate name-plate permanently affixed in a conspicuous location. The plate shall bear the manufacturer's name, model designation, serial number if applicable, and other pertinent information such as horsepower, speed, capacity, type, direction of rotation, etc. The plate shall be made of corrosion-resisting metal with raised or depressed lettering and contrasting background.

2.10 INSTRUCTION PLATES

The pump shall be equipped with suitably located instruction plates, including any warnings and cautions, describing any special and important procedures to be followed in starting, operating, and servicing the equipment. Plates shall be made of corrosion-resisting metal with raised or depressed lettering and contrasting background.

2.11 GUARDS AND COVERS

Safety guards and/or covers shall be provided wherever necessary to protect the operators from accidental contact with moving parts. Guards and covers shall be of sheet steel, expanded metal, or another acceptable material and removable for disassembly of the pump.

2.12 SPARE PARTS

The Contractor shall furnish the following spare parts:

- a. One complete replacement set of bearings, bearing shells, journal sleeves, shaft coupling, if applicable, and seals for one main pump.
- b. One complete replacement set of wearing parts for the packing gland for one pump, and sufficient packing for all main pumps.
- c. Fifty percent of each size and length of bolt, nut and washer used on one main pump assembly.

PART 3 EXECUTION

3.1 INSTALLATION

The installation of the equipment furnished under this section and related drive machinery furnished under other sections of this specification shall be in accordance with the approved Installation and Erection Instructions Manual required by paragraph SUBMITTALS. The erection engineer(s), familiar with the equipment to be installed, shall supervise the handling, installation, start-up and testing of the equipment as required by paragraph ERECTION ENGINEER(S).

3.2 FIELD TESTS

3.2.1 Dry Tests

Pumping unit, consisting of pump motor and right-angle gear reducer shall be tested in the dry to determine whether it has been properly erected and connected. Such test shall be made when, and as, directed by Contracting Officer. After pumping unit has been completely assembled, including all rotating elements and lubrication system, operate at full rated speed for three 15-minute periods, to assure proper alignment and satisfactory operation. Vibration measurements, in both axial and radial directions, will be made by Government. Measurements will be made on pump casing flanges, pump base plate, and, if possible, on bearing housings. Vibration measurements will be analyzed by Government personnel to determine acceptability of pumping installation. Vibration amplitude levels shall conform to those described in paragraph SYSTEM DESCRIPTION, subparagraph PERFORMANCE REQUIREMENTS. Results will be made available to Contractor upon request. Contractor may elect, at his own expense, to check data obtained by Government. Erecting engineers, as specified in Paragraph 1.9, shall assist Contracting Officer in this test. Pumping unit shall be operated at full-rated speed until the temperature rate of rise has stabilized for all bearings. Bearings' temperature shall be considered stabilized when the rate of rise does not exceed 1 degree Fahrenheit in five minutes. Dry test run shall be repeated if it is necessary to interrupt the test before all bearing temperatures have become stable. Should tests reveal that there is a design deficiency or a manufacturing error in pumping unit components, the problem shall be promptly corrected by and at the expense of Contractor.

3.2.2 Wet Tests

Pumping units shall be run under operating conditions to ensure that there are no leaks at any of the made-up joints. Government personnel will measure vibration levels during wet testing. Each pump shall be operated for a period of 2 hours. If deficiencies require correction, pumping unit shall be

retested after deficiency has been corrected. Should there be insufficient water to perform test, Contracting Officer may, at his option, waive the test.

End of Section

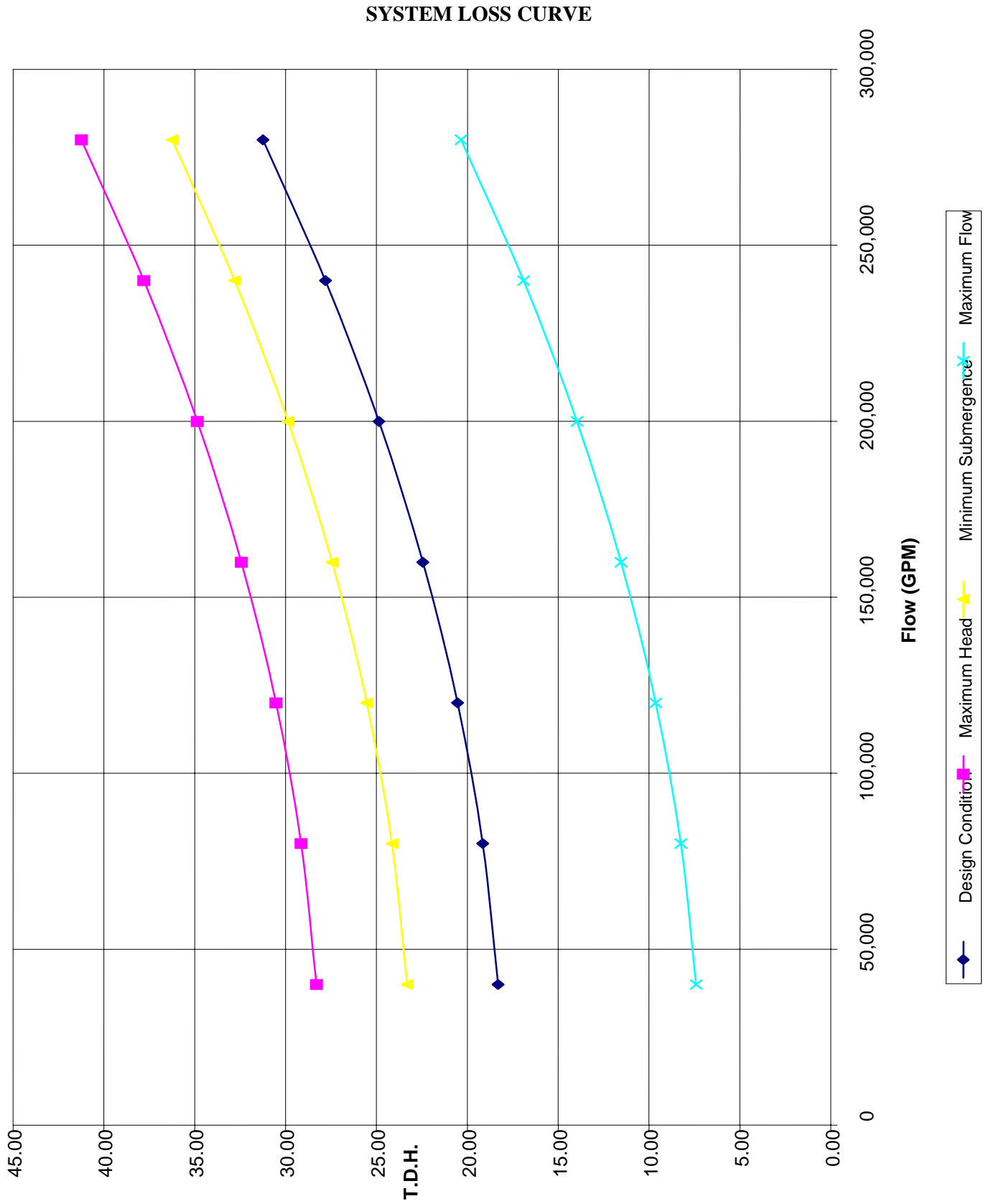


FIGURE 1

BEARING RTD INSTALLATION

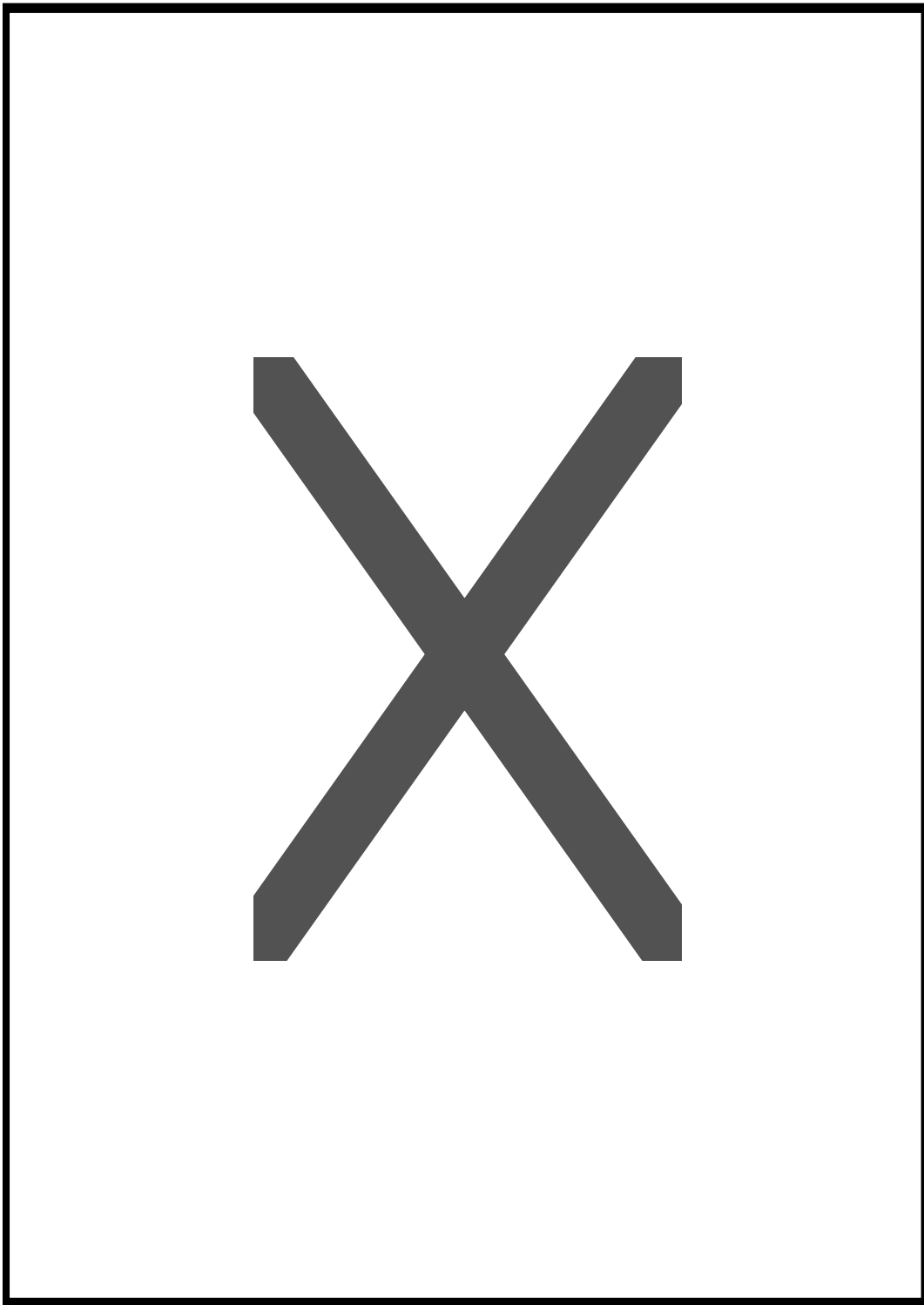


FIGURE 2

DIVISION 15 - MECHANICAL

SECTION 15170

ELECTRIC MOTORS, 3-PHASE HORIZONTAL INDUCTION TYPE

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SECTION 15170

ELECTRIC MOTORS, 3-PHASE HORIZONTAL INDUCTION TYPE

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 123	(1997a) Zinc (Hot Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 153	(1995) Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM B 344	(1992) Drawn or Rolled Nickel-Chromium and Nickel-Chromium Iron Alloys for Electrical Heating Elements

ANTI-FRICTION BEARING MANUFACTURER'S ASSOCIATION (AFBMA)

AFBMA 9	(1990) Load Ratings and Fatigue Life for Ball Bearings
AFBMA 11	(1990) Load Ratings and Fatigue Life for Roller Bearings

INSTITUTE OF ELECTRICAL AND ELECTRONIC ENGINEERS (IEEE)

IEEE Std 85	(1973; R 1986) Airborne Sound Measurements on Rotating Electric Machinery
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NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(1993; Rev 1) Motors and Generators
NEMA WC 7	(1998; Rev 2, 1992) Cross-Linked-Thermosetting-Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy

1.2 GENERAL REQUIREMENTS

1.2.1 Corrosion Prevention and Finish Painting

The equipment provided under these specifications will be subjected to severe moisture conditions and shall be designed to render it resistant to corrosion from such exposure. The general requirements to be followed to mitigate corrosion are specified below. Any additional special treatment or requirement considered necessary for any individual items is specified under the respective item. However, other

corrosion-resisting treatments that are the equivalent of those specified herein may, with the approval of the Contracting Officer, be used.

1.2.1.1 Fastenings and Fittings

Where practicable, all screws, bolts, nuts, pins, studs, springs, washers, and other similar fittings shall be of corrosion-resisting material or shall be treated in an approved manner to render them resistant to corrosion.

1.2.1.2 Corrosion-Resisting Materials

Corrosion-resisting steel, copper, brass, bronze, copper-nickel, and nickel-copper alloys are acceptable corrosion-resisting materials.

1.2.1.3 Corrosion-Resisting Treatments

Hot-dip galvanizing shall be in accordance with ASTM A 123 or ASTM A 153 as applicable. Other corrosion-resisting treatments may be used if approved by the Contracting Officer.

1.2.1.4 Frames

Motor frames, end bells, covers, conduit boxes, and any other parts, if of steel, and if they will be coated during the process of insulating the windings, shall be cleaned of rust, grease, millscale, and dirt, and then treated and rinsed per manufacturer's standard process. If any of the above-listed parts are not coated during the process of insulating the windings then, in addition to the above, they shall be given one coat of primer and then two coats of manufacturer's standard moisture-resistant coating, processed as required.

1.2.1.5 Cores

The assembled motor core shall be thoroughly cleaned and then immediately primed by applying a minimum of two coats of a moisture-resisting and oil-resisting insulating compound. Air gap surfaces shall be given a minimum of one coat.

1.2.1.6 Shafts

Exposed surfaces of motor shafts shall be cleaned of rust, grease, and dirt and, except for bearing surfaces, given one coat of a zinc molybdate or equivalent primer and two coats of a moisture-proof coating, each cured as required. Shafts of a corrosion-resisting steel may be used in lieu of the above treatment.

1.2.1.7 Finish Painting

Finish painting of all equipment shall be in accordance with the standard practice or recommendation of the manufacturer, as approved by the Contracting Officer.

1.2.2 Nameplates

Nameplate data shall include rated voltage, rated full-load amperes, rated horsepower, service factor, number of phases, RPM at rated load, frequency, code letter, locked-rotor amperes, duty rating, insulation system designation, and maximum ambient design temperature.

1.3 SYSTEM DESCRIPTION

The work under this section includes providing all labor, equipment, and material and performing all operations required to design, manufacture, assemble, test, and package and deliver the horizontal induction motors for driving pumps specified under Section 15160 VERTICAL PUMPS, MIXED-FLOW IMPELLER-TYPE. These motors shall be supplied complete with all accessories, spare parts, tools, and manufacturer's data and instructions as specified herein.

1.4 SUBMITTALS

Government approval is required for submittals with "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES.

SD-01 Data

Insulated Windings; GA.

A detailed description of and specification for the manufacturing process and the materials and the insulating varnish or compound used in insulating the windings shall be submitted to the Contracting Officer for approval before manufacture of the motors is commenced. If, in the opinion of the Contracting Officer, the insulation proposed is not of the quality specified and if the methods of manufacture are not considered to be in accordance with best modern practice, the motors will not be accepted.

Duty Cycle; GA.

An analysis to verify that the motor, when operated in accordance with the duty cycle specified, will not undergo injurious temperature rise. If the duty cycle cannot be met with a standard NEMA design motor, the motor manufacturer shall provide a description of proposed modifications to provide such compliance.

Motor Design Curves; FIO.

Six (6) copies of motor design (characteristic) curves or tabulated data (test or calculated), indicating the speed, power factor, efficiency, current, and kilowatt input, all plotted or tabulated against torque or percent load as abscissa. The base value shall be given whether ANSI or IEEE standard system is used.

Six (6) copies of motor speed-torque curves for the pump starting operation. The motor speed-torque curves shall be plotted for the following values of voltage at the motor terminals: The output of the soft start medium voltage starter supplied at rated and 90 percent of rated motor voltage. The pump torque curve shall be plotted for starting and accelerating against maximum head. Computations shall be furnished to demonstrate that the motor furnished will carry the pump load under all the foregoing conditions.

Motors; GA.

Six (6) copies of complete descriptive specification of each type and size motor provided, with necessary cuts, photographs, and drawings to clearly indicate the construction of the motor, the

materials and treatments used to prevent corrosion of parts, bearing construction, and type of insulation used on all windings. Submittal shall include all information required for selection of protective and control equipment and for operational setting, such as, but not limited to, normal and maximum operation temperature for windings and bearings, overload trip setting for motor at pump maximum head condition and starting times for starting at rated and 90 percent starter voltage. Contracting Officer's approval shall be obtained in writing prior to the commencement of manufacture of motors.

Government Study Design Data; FIO.

Six (6) copies of the following data will be supplied to the Government for completion of its Motor Torque and Accelerating Time Studies (MTATS):

- a. Complete equivalent circuit data referred to the stator with friction, windage, and stray load losses.
- b. Current, power factor, and torque versus speed (0-100 percent, inclusive, in 1 percent increments up to 95 percent and in 0.1 percent increments above 95 percent) and load (0-125 percent, inclusive, in 25 percent increments) as a function of line voltage (from 80 percent to 110 percent, inclusive, in 5 percent increments), for rated and 90 percent of rated voltage at starter. Only tabulated data will be required.
- c. Load inertia, Wk^2 of motor rotating parts, pound-foot².
- d. Load inertia, Wk^2 of pump rotating parts (wet), pound-foot².

Spare Parts List; FIO.

Six (6) copies of a complete list of renewal parts with prices for each different rating of motor. This list shall accompany the instruction manual.

SD-04 Drawings

Motors; GA.

Six (6) copies of equipment foundation dimension outline drawings with weights, nameplate data, and details showing method of mounting and anchoring the motor. Contracting Officer's approval shall be obtained in writing prior to the commencement of manufacture of motors.

SD-09 Reports

Starting Capabilities; FIO.

Six (6) copies of certified test reports, when available, of tests previously performed on motors of each type and size specified or calculated data to substantiate the motor's capability to conform to the requirements of paragraph STARTING CAPABILITIES.

Factory Tests; FIO.

Six (6) copies of test reports recording all data obtained during the tests specified in paragraph FACTORY TESTS shall be provided to the Contracting Officer for each motor used. Test reports shall

include performance curves indicating the results of paragraph COMPLETE TEST as follows. The base value shall be given whether ANSI or IEEE standard system is used:

- a. Excitation Tests. Volts as abscissa versus amperes and watts as ordinates.
- b. Impedance Tests. Volts as abscissa versus amperes and watts as ordinates.
- c. Performance Test. Torque or percent load as abscissa versus efficiency, power factor, amperes, watts, and RPM or percent slip as ordinates.
- d. Speed-Torque Test. Torque in foot-pounds as abscissa versus speed in RPM as ordinate.
- e. Insulation Resistance-Temperature Test. Test result values shall be plotted on semilogarithmic graphs, the insulation resistance values as logarithmic ordinates and the temperature values as uniform abscissas. For comparison purposes, a curve indicating the safe operating value of insulation resistance shall be plotted on the same sheet with the insulation resistance-temperature test curve.

SD-13 Certificates

Power Factor and Efficiency; GA.

Certification of guaranteed value of power factor and efficiency for full load, 3/4 full load, and 1/2 full load.

Factory Tests; GA.

Six (6) certified copies of the results of a "Complete Test" for duplicate equipment will be accepted in lieu of the "Complete Test" as specified in the paragraph FACTORY TESTS, subparagraph COMPLETE TEST, for equipment of the respective rating and type. No substitute will be accepted for the "Check Test."

SD-19 Operation and Maintenance Manuals

Instruction Manuals; FIO.

Six (6) copies of complete instructions for the proper installation, inspection, and maintenance of the machines provided for this particular service. Instruction manuals shall be submitted to the Contracting Officer not later than the date the equipment is shipped from the manufacturer's plant. The instructions shall include a cross-sectional drawing indicating the major component parts of the motor and the procedure for disassembly.

PART 2 PRODUCTS

2.1 MOTORS

The motors to be supplied under these specifications shall be of the horizontal shaft type as required by the pump manufacturer, normal starting torque, low starting current, squirrel-cage induction type, designed for full voltage starting, of drip-proof construction, and shall conform to the applicable requirements of NEMA MG 1, except as hereinafter specified. The motors will be started and operated

by a constant-speed, soft starter specified in Section 16405 MEDIUM VOLTAGE ELECTRICAL SYSTEM.

2.1.1 Rating

Each motor shall be wound for 3-phase, 60-Hz, alternating current, and for the respective operating voltage listed below:

PLANT	PUMP	SERVICE	MOTOR OPERATING VOLTAGE	RPM	HORSEPOWER
New Madrid	1	Pump	4160	1200	2000
New Madrid	2	Pump	4160	1200	2000
New Madrid	3	Pump	4160	1200	2000

The motor shall be designed for operation in a 40 degrees C ambient temperature and all temperature rises shall be above this ambient temperature. The rated horsepower of the motor shall be not less than 110 percent of the determined maximum load requirement of the pump. Motors shall have a service factor of 1.15 or shall be applied using a service factor of 1.0 if standard service factor is greater than 1.0. The temperature rise above the ambient temperature for continuous rated full-load conditions and for the class of insulation used shall not exceed the values given in NEMA MG 1, paragraph 12.42 or paragraph 20.40.

2.1.2 Operating Characteristics

2.1.2.1 Torques

Starting torque shall be sufficient to start the pump to which the motor will be connected under the maximum conditions specified, but in no case shall the starting torque be less than 60 percent of full-load torque. Breakdown torque shall be not less than 200 percent of full-load torque.

2.1.2.2 Locked-Rotor Current

The locked-rotor current shall not exceed 600 percent of normal full-load running current.

2.1.2.3 Starting Capabilities

Large motors, on the basis of the load torque characteristics and the load inertia Wk^2 listed in NEMA MG 1, paragraphs 20.41 and 20.42, shall as a minimum be capable of making the starts required in NEMA MG 1, paragraph 20.43. Smaller motors shall conform to the requirements in NEMA MG 1, paragraph 12.50.

2.1.2.4 Duty Cycle

Each motor, when operating at rated voltage and frequency and on the basis of the connected pump load inertia Wk^2 and the speed-torque characteristics of the load during starting conditions as furnished by the pump manufacturer, shall be capable of performing on a continuous basis the following motor duty cycle without injurious temperature rise: operation at rated load over a period of approximately 1 hour and a standstill period of not less than 10 minutes. A starting information nameplate setting forth the starting capabilities shall be provided on each motor. This nameplate shall also include the minimum time at standstill and the minimum running time prior to an additional start.

2.1.2.5 Balance

The balance for each motor when measured in accordance with NEMA MG 1, paragraph 12.06 or paragraph 20.53, shall not exceed the values specified. Each motor's characteristics shall be such that the provisions of Section 15160 VERTICAL PUMPS, MIXED-FLOW IMPELLER TYPE paragraph TESTS, INSPECTIONS, AND VERIFICATIONS are met.

2.1.2.6 Noise

All motors shall operate at a noise level less than 85 decibels A-weighted mean sound pressure level (dBA). Noise shall be determined in accordance with IEEE Std 85. The specified noise limit applies for a reference distance of one meter for free-field conditions.

2.1.2.7 Power Factor and Efficiency

The power factor and efficiency at full load, 3/4 full load, and 1/2 full load shall be not less than 88.5, 88.5, 81.0 and 96.3, 96.3, 95.8, respectively. Motors will be rejected if factory tests specified in paragraph FACTORY TESTS do not demonstrate that these values will be met or exceeded.

2.1.2.8 Eyebolts

Eyebolts, lugs, or other approved means shall be provided for assembling, dismantling, and removing the motor, if required, from above using an overhead crane. All lifting devices required for use in conjunction with the crane shall be provided with the motor.

2.1.3 Insulated Windings

All motors shall have a nonhygroscopic, sealed, fungus-resisting insulation of a type designed and constructed to withstand severe moisture conditions, and insofar as practicable, to operate after long periods of idleness without previous drying out. All windings and connections shall be of the sealed type as defined in NEMA MG 1 paragraph 1.27.2. Insulated windings, unless otherwise approved, shall be completely assembled in the motor core before impregnating with the insulating compound. The compound shall consist of 100 percent solid resin. Impregnation of the windings with the insulating compound shall be by vacuum impregnation method followed by baking. The procedure shall be repeated as often as necessary to fill in and seal over the interstices of the winding, but in no case shall the number of dips and bakes be less than two dips and bakes when the vacuum method of impregnation is used. Insulation to ground shall be processed on the coil. The completed stator shall be of a type that is capable of passing the submerged or sprayed water test, as applicable, required by NEMA MG 1 paragraph 20.49.

2.1.3.1 Form Wound Machines

Form wound coils shall be used on motors supplied in NEMA frames larger than 445 TP. The components of the insulation system and the coil insulation of the rectangular conductors shall conform to Class F insulation with a 110 percent continuous overload factor as defined in NEMA MG 1, paragraph 1.66. The completed stator windings and connections shall be of the sealed type as defined in NEMA MG 1 paragraph 1.27.2. Insulation to ground shall be processed on the coil. Slot tubes or cells are not acceptable. The insulation shall be of adequate thickness and breakdown strength throughout the length of the coil. Mica shall be used in the slot portion and shall be of adequate thickness to withstand the dielectric tests specified in paragraph FACTORY TESTS. Form wound

coils shall be of such uniformity that the stator windings on motors of equal ratings shall be alike, in shape and size, and be interchangeable.

2.1.3.2 Bracing

Coils of all windings shall be fully braced so that vibration is virtually eliminated during repeated starts as required by the duty cycle specified as well as during normal operation. If a tied system is used it shall be such that no tie depends upon the integrity of any other tie within the system.

2.1.4 Thermal Protection

For motors rated 500 hp or greater, 100 ohm platinum resistance temperature detectors (two per phase) shall be provided in accordance with NEMA MG 1, paragraph 20.63. Detectors shall have a copper resistance element having a resistance of 10 ohms at 25 degrees C. Leads shall be terminated on the terminal blocks specified in paragraph MOTOR TERMINALS AND BOXES. All outgoing wiring shall terminate on the terminal blocks specified in paragraph MOTOR TERMINALS AND BOXES.

2.1.5 Winding Heaters

Heaters shall be wrapped around the winding end turns. They shall be designated for operation on 120 volts, 1-phase, 60 Hz, alternating current and of sufficient capacity or wattage that, when energized, they will hold the temperature of the motor windings approximately 10 degrees C above the ambient temperature. They shall be designed for continuous operation and to withstand at least 10 percent overvoltage continuously. The rate of heat dissipation shall be uniform throughout the effective length of the heater. Heaters installed around the winding end turns shall consist of the required turns of heating cable wrapped around the end turns and secured in place before the winding is impregnated.

2.1.5.1 Heating Element

Heating element shall conform to the requirements of ASTM B 344 for an 80 percent nickel and 20 percent chromium alloy or standard design of the manufacturer.

2.1.5.2 Sheath

Sheath shall be of a corrosion-resisting, nonoxidizing metal and shall have a wall thickness not less than 0.025 inch.

2.1.5.3 Insulation

Insulation shall be a granular mineral refractory material, highly resistant to heat, and shall have a minimum specific resistance of 1,000 megohms per inch cubed at 1,000 degrees F. Insulation for the heating cable (winding wraparound type) type heaters shall be suitable for a conductor temperature of 180 degrees C.

2.1.5.4 Terminals

Terminals of the heater, including the leads, shall be watertight and shall be provided with leads suitable for making connections to the drip-proof terminal box provided in paragraph MOTOR TERMINALS AND BOXES. The terminal box shall be readily accessible through the crating so that winding heaters can be energized while motors are in storage.

2.1.6 Shafts

Shafts shall be made of high grade steel, finished all over, and of ample size to drive the pumps under maximum load conditions. Shafts shall be of solid types as required by the pump manufacturer. See paragraph GENERAL REQUIREMENTS for treatment against corrosion.

2.1.7 Bearings

2.1.7.1 Loading

Bearings shall be capable of withstanding all stresses incidental to the normal operation of the unit. Provide a 100 ohm platinum RTD on each bearing.

2.1.7.2 Thrust Bearings

Thrust bearings shall be of the antifriction type of either the ball or roller type. Tandem or series bearing assemblies shall not be used. Antifriction bearings shall conform to the requirements of AFBMA 9 and AFBMA 11.

2.1.7.3 Guide Bearings

Guide bearings shall be of the sleeve or antifriction type of either the ball or roller type or a combination of sleeve and antifriction bearings.

2.1.7.4 Lubrication

Bearings shall be either oil or grease lubricated and the lubricant used shall contain a corrosion inhibitor. Type and grade of lubricant used shall be shown on a special nameplate which shall be attached to the frame of the motor adjacent to the bearing lubricant filling device. In addition to the quantity of lubricant required to fill the system initially, spare lubricant shall be provided in sufficient quantity to purge and refill the system.

2.1.7.5 Housings

Bearing housings shall be of a design and method of assembly that will permit ready removal of the bearings, prevent escape of lubricant and entrance of foreign matter, and protected by the lubricant when the motor is idle. Except for prelubricated antifriction bearings of an approved type, suitable means shall be provided to apply and drain the lubricant. Oil-lubricated bearing housings shall be provided with oil-level indicator gauges that will be readily visible.

2.1.7.6 Cooling

All bearings shall be self-cooling unless otherwise specifically approved by the Contracting Officer.

2.1.7.7 Rating

Antifriction bearings shall be rated on the basis of a minimum life factor of 8,800 hours, based on the life expectancy of 90 percent of the group, unless otherwise approved by the Contracting Officer.

2.1.7.8 Shaft Currents

Bearings shall be insulated or otherwise protected against the damaging effects of shaft currents.

2.1.8 Space Heater

If recommended by the surge protection manufacturer, a space heater of adequate capacity and rated 120 volts shall be provided. Space heaters shall have a maximum watt density of 20 watts per square inch.

2.2 MOTOR TERMINALS AND BOXES

2.2.1 Stator Terminal Box

Drip-proof cast iron or steel conduit terminal boxes, treated as specified for frames in paragraph GENERAL REQUIREMENTS, shall be supplied for housing the stator lead connections stress cones and shall have adequate space to facilitate the installation and maintenance of cables and equipment. The motor will be terminated with shielded conductors requiring stress cone type terminations. The terminal box shall be oversized accordingly

Boxes shall have a bolted cover providing unrestricted access, be mounted on the motor frame, and shall have an auxiliary floor supporting structure, when required, supplied by the motor manufacturer. Conduit entrance shall be from the bottom. The boxes shall be designed to permit removal of motor supply leads when the motor is removed. A "HIGH VOLTAGE - 4160 VOLTS" warning sign shall be provided on the cover of the box..

2.2.2 Stator Terminals

Insulated terminal leads shall receive a treatment equal to that of the motor winding. Leads shall be brought out of the stator frame and shall be provided with terminal lugs for connection to the motor supply wiring.

2.2.3 Grounding

A ground bus and means for external connection to the station grounding system shall be provided in the stator terminal box and on the motor base.

2.2.4 Accessory Leads and Boxes

Terminal leads for motor winding space heaters, resistance temperature detectors and any other auxiliary equipment shall be brought into conveniently located terminal boxes provided with terminal blocks for extension by others. The terminal boxes shall be drip-proof and treated as specified for frames in paragraph GENERAL REQUIREMENTS. All auxiliary wiring shall be stranded copper conductors with 600-volt flame-retardant insulation conforming to NEMA WC 7, except temperature detector leads may be in accordance with the manufacturer's standard practice. All wiring and terminals shall be properly identified.

2.3 WRENCHES, TOOLS, AND SPECIAL EQUIPMENT

The Contractor shall provide all nonstandard and special equipment required for dismantling, reassembly, and general maintenance of the motor units. The Contractor shall also provide one

complete set of lifting attachments such as detachable eyebolts or special slings for handling various parts with a hoist.

2.4 FACTORY TESTS

One motor of each rating type, selected at random by the Contracting Officer, shall be given a complete test. The remainder of the motors shall be given a check test. All complete tests shall be witnessed by the Contracting Officer unless waived in writing by him.

2.4.1 Complete Test

A complete test of a motor shall include the following:

- a. Excitation Test.
- b. Impedance Test.
- c. Performance and Speed-Torque Test. (Prony brake or other equivalent method.)
- d. Temperature Test. Made on completion of paragraph c above. (If screens are provided over openings, test will be made with screens removed and by thermometer).
- e. Insulation Resistance-Temperature Test. Shall be taken following heat run, readings being taken at approximately 10 degrees C intervals. Temperature shall be determined by the resistance method.
- f. Cold and Hot Resistance Measurement.
- g. Dielectric Test.
- h. Sound Level Test. In accordance with IEEE Std 85.
- i. Vibration Measurement. In accordance with NEMA MG 1 paragraph 20.54.
- j. Conformance Tests. In accordance with NEMA MG 1 paragraph 20.47.

2.4.2 Check Test

A check test of a motor shall include the following:

- a. Routine test per NEMA MG 1 paragraph 12.51 or NEMA MG 1 paragraph 20.47.
- b. Cold resistance measurement.
- c. Insulation resistance and winding temperature at time the insulation resistance was measured.
- d. Conformance Test. In accordance with NEMA MG 1 paragraph 20.47.
- e. Vibration measurement in accordance with NEMA MG 1 paragraph 12.07 or NEMA MG 1 paragraph 20.54.

2.4.3 Form Wound Coil Test

All form wound coils, either before or after they are placed in the slots, shall be tested for short circuits between turns of the individual coils by applying a high frequency voltage of not less than 75 percent of the voltage for which the machine is insulated, or by applying a surge test voltage of equivalent value to the terminals of each coil. Equivalent surge voltage shall be a wave whose peak value is equal to 1.06 times the voltage for which the motor is insulated.

2.4.4 Winding Space Heater Test

Each winding space heater unit shall be tested at the factory for successful operation and dielectric strength.

PART 3 EXECUTION

3.1 FIELD TESTING

Field testing shall be performed in the presence of the Contracting Officer. The Contractor shall notify the Contracting Officer 10 days prior to conducting tests. The Contractor shall furnish all materials, labor, and equipment necessary to conduct field tests. The Contractor shall perform all tests and inspection recommended by the manufacturer unless specifically waived by the Contracting Officer. The Contractor shall maintain a written record of all tests which includes date, test performed, personnel involved, devices tested, serial number and name of test equipment, and test results. All field test reports will be signed and dated by the Contractor.

3.1.1 Safety

The Contractor shall provide and use safety devices such as rubber gloves, protective barriers, and danger signs to protect and warn personnel in the test vicinity. The Contractor shall replace any devices or equipment which are damaged due to improper test procedures or handling.

3.1.2 Motor Tests

- a. Phase rotation test to ensure proper directions.
- b. Operation and sequence of reduced voltage starters.
- c. High potential test on each winding to ground.
- d. Insulation resistance of each winding to ground.
- e. Vibration test.
- f. Dielectric absorption test on motor and starter.

3.2 OPERATING TESTS

After the installation is completed, and at such time as the Contracting Officer may direct, the Contractor shall conduct operating tests for approval. The equipment shall be demonstrated to operate

in accordance with the specified requirements. An operating test report shall be submitted in accordance with paragraph SUBMITTALS.

Test Forms are appended to Section 16415 ELECTRICAL WORK, INTERIOR, APPENDIX 1 - MOTOR CERTIFICATION DATA. These forms shall be filled out for each individual motor, signed and submitted as specified.

Upon commissioning, the Contractor shall fill out the test forms. Upon starting the motor for the first time and repeating when water is available to pump, record the multifunction relay metering data, levels and other relevant data.

3.3 FIELD SERVICE

3.3.1 Installation Engineer

After delivery of the equipment, the Contractor shall furnish one or more field engineers, regularly employed by the equipment manufacturer to supervise the installation of equipment, assist in the performance of the onsite tests, oversee initial operations, and instruct personnel as to the operational and maintenance features of the equipment.

3.4 ACCEPTANCE

Final acceptance of the facility will not be given until the Contractor has successfully completed all tests and after all defects in installation, material or operation have been corrected.

3.4.1 Start-Up Service

The supplier of the motor controller described herein shall have a factory trained service representative in domestic residence within 150 miles (average) of the job site. The factory representative shall be trained in the maintenance and troubleshooting of the equipment as specified herein.

Start-up service is to be included for a period of not less than 35 hours, but in no case less than the time required to satisfactorily commission and operate the pump controllers.

3.4.2 Documentation

Six (6) Instruction Manuals shall be provided with the controller at time of shipment.

3.4.3 Spare Parts

Recommended spare parts list and prices shall be supplied with the bid. Also, the address of the manufacturer's closest parts stocking location shall be provided.

End of Section

DIVISION 15 - MECHANICAL

SECTION 15250

THERMAL INSULATION FOR MECHANICAL SYSTEMS

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SECTION 15250

THERMAL INSULATION FOR MECHANICAL SYSTEMS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only. At the discretion of the government, the manufacturer of any material supplied will be required to furnish test reports pertaining to any of the tests necessary to assure compliance with the standard or standards referenced in this specification.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 167	(1996) Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A 580	(1995a) Stainless and Heat-Resisting Steel Wire
ASTM B 209	(1996) Aluminum and Aluminum-Alloy Sheet and Plate
ASTM C 195	(1995) Mineral Fiber Thermal Insulating Cement
ASTM C 449	(1995) Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement
ASTM C 533	(1995) Calcium Silicate Block and Pipe Thermal Insulation
ASTM C 534	(1994) Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
ASTM C 547	(1995) Mineral Fiber Pipe Insulation
ASTM C 552	(1991) Cellular Glass Thermal Insulation
ASTM C 553	(1992) Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
ASTM C 612	(1993) Mineral Fiber Block and Board Thermal Insulation
ASTM C 647	(1995) Properties and Tests of Mastics and Coating Finishes for Thermal Insulation
ASTM C 795	(1992) Thermal Insulation for Use in Contact With Austenitic Stainless Steel

ASTM C 871	(1995) Test Methods for Chemical Analysis of Thermal Insulation Materials for Leachable Chloride, Fluoride, Silicate, and Sodium Ions
ASTM C 916	85(1996)e1 Adhesives for Duct Thermal Insulation
ASTM C 920	(1998) Elastomeric Joint Sealants
ASTM C 921	(1989 R; 1996) Determining the Properties of Jacketing Materials for Thermal Insulation
ASTM C 1126	(1998) Specification for faced or Unfaced Rigid Cellular Phenolic Thermal Insulation
ASTM D 3278	(1996)e1 Test Methods for Flash Point of Liquids by Setaflash Closed-Cup Apparatus
ASTM E 84	(1998) Surface Burning Characteristics of Building Materials
ASTM E 96	(1995) Water Vapor Transmission of Materials

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-69	(1996) Pipe Hangers and Supports - Selection and Application
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MIDWEST INSULATION CONTRACTORS ASSOCIATION (MICA)

MICA-01	(1993) National Commercial & Industrial Insulation Standards
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1.2 SYSTEM DESCRIPTION

Field-applied insulation and accessories on mechanical systems shall be as specified herein; factory-applied insulation is specified under the piping, duct or equipment to be insulated. Field applied insulation materials required for use on Government-furnished items as listed in the 00800 SPECIAL CONTRACT REQUIREMENTS shall be furnished and installed by the Contractor.

1.3 GENERAL QUALITY CONTROL

1.3.1 Standard Products

Materials shall be the standard products of manufacturers regularly engaged in the manufacture of such products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening.

1.3.2 Installer's Qualifications

Qualified installers shall have successfully completed three or more similar type jobs within the last 5 years.

1.3.3 Surface Burning Characteristics

Unless otherwise specified, insulation not covered with a jacket shall have a flame spread rating no higher than 75 and a smoke developed rating no higher than 150. The outside surface of insulation systems which are located in air plenums, in ceiling spaces, and in attic spaces shall have a flame spread rating no higher than 25 and a smoke developed rating no higher than 50. Insulation materials located exterior to the building perimeter are not required to be fire-rated. Flame spread and smoke developed ratings shall be determined by ASTM E 84. Insulation shall be tested in the same density and installed thickness as the material that shall be used in the actual construction. Jackets shall comply with the flame spread and smoke developed ratings of 25/50 as determined by ASTM E 84.

1.3.4 Identification of Materials

Packages or standard containers of insulation, jacket material, cements, adhesives, and coatings delivered for use, and samples required for approval shall have manufacturer's stamp or label attached giving the name of the manufacturer and brand, and a description of the material.

1.4 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-14 Samples

Thermal Insulation Materials; GA.

A complete list of materials, including manufacturer's descriptive technical literature, performance data, catalog cuts, and installation instructions. The product number, k-value, thickness and furnished accessories for each mechanical system requiring insulation shall be included. Materials furnished under this section of the specification shall be submitted at one time.

After approval of materials and prior to applying insulation a booklet shall be prepared and submitted for approval. The booklet shall contain marked-up MICA-01 plates (or detail drawings showing the insulation material and insulating system) for each pipe, duct, or piece of equipment which is/are required to be insulated per this specification. The MICA plates shall be marked-up showing the materials to be installed in accordance with the requirements of this specification for the specific insulation application. The Contractor shall submit all MICA plates required to show the entire insulating system, including plates required to show insulation penetrations, vessel bottom and top heads, legs, and skirt insulation as applicable. If the Contractor elects to submit detailed drawings instead of marked-up MICA plates, the detail drawings shall show cut-away, section views, and details indicating each component of the insulation system and showing provisions for insulating jacketing, and sealing portions of the equipment. For each type of insulation installation on the drawings, provide a label which identifies each component in the installation (i.e., the duct, insulation, adhesive, vapor retarder, jacketing, tape, mechanical fasteners, etc.) Indicate insulation by type and manufacturer. Three copies of the booklet shall be submitted at the jobsite to the Contracting Officer. One copy of the approved booklet shall remain with the insulation Contractor's display sample and two copies shall be provided for Government use.

After approval of materials actual sections of installed systems properly insulated in accordance with the specification requirements shall be displayed. Such actual sections must remain accessible to inspection throughout the job and will be reviewed from time to time for controlling the quality of the work throughout the construction-site. Each material used shall be identified, by indicating on an attached sheet the specification requirement for the material and the material by each manufacturer intended to meet the requirement. Display sample sections will be inspected at the jobsite by the Contracting Officer. Approved display sample sections shall remain on display at the jobsite during the construction period. Upon completion of construction, the display sample sections will be closed and sealed.

Pipe Insulation Display Sections: Display sample sections shall include as a minimum an elbow or tee, a valve, dielectric unions and flanges, a hanger with protection shield and insulation insert, or dowel as required, at support point, method of fastening and sealing insulation at longitudinal lap, circumferential lap, butt joints at fittings and on pipe runs, and terminating points for each type of pipe insulation used on the job, and for hot pipelines and cold pipelines, both interior and exterior, even when the same type of insulation is used for these services.

Duct Insulation Display Sections: Display sample sections for rigid and flexible duct insulation used on the job. A display section for duct insulation exposed to weather shall be protected by enclosing with a temporary covering.

1.5 STORAGE

Materials shall be delivered in the manufacturer's unopened containers. Materials delivered and placed in storage shall be provided with protection from weather, humidity, dirt, dust and other contaminants by the Contractor. Insulation material and supplies that become dirty, dusty, wet, or otherwise contaminated may be rejected by the Contracting Officer.

PART 2 PRODUCTS

2.1 GENERAL MATERIALS

Materials shall be compatible and shall not contribute to corrosion, soften, or otherwise attack surfaces to which applied in either the wet or dry state. Materials to be used on stainless steel surfaces shall meet ASTM C 795 requirements. Materials shall be asbestos free and conform to the following:

2.1.1 Adhesives

2.1.1.1 Acoustical Lining Insulation Adhesive

Insulation shall be applied in cut-to-size pieces attached to the interior of the duct with a nonflammable, fire-resistant adhesive conforming to ASTM C 916, Type I. Exposed edges of the liner at the duct ends and at other joints where the lining will be subject to erosion shall be coated with a heavy brush coat of the nonflammable, fire-resistant adhesive to prevent delamination of glass fibers.

2.1.1.2 Mineral Fiber Insulation Cement

Cement shall be in accordance with ASTM C 195.

2.1.1.3 Lagging Adhesive

Lagging adhesives shall be nonflammable and fire-resistant and shall have flame spread and smoke developed ratings of 25/50 when measured in accordance with ASTM E 84. Adhesives shall be either the Class 1 or Class 2 type as defined here. Class 1 adhesive shall be pigmented white and be suitable for bonding fibrous glass cloth to faced and unfaced fibrous glass insulation board; for bonding cotton brattice cloth to faced and unfaced fibrous glass insulation board; for sealing edges of and bounding fibrous glass tape to joints of fibrous glass board; or for bonding lagging cloth to thermal insulation. Class 2 adhesive shall be pigmented white and be suitable for attaching fibrous glass insulation to metal surfaces. Lagging adhesives shall be applied in strict accordance with the manufacturer's recommendations.

2.1.2 Contact Adhesive

Adhesive may be dispersed in a nonhalogenated organic solvent with a low flash point (flash point less than minus 25 degrees F when tested in accordance with ASTM D 3278) or, dispersed in a nonflammable organic solvent which shall not have a fire point below 200 degrees F. The adhesive shall not adversely affect, initially or in service, the insulation to which it is applied, nor shall it cause any corrosive effect on metal to which it is applied. Any solvent dispersing medium or volatile component of the adhesive shall have no objectionable odor and shall not contain any benzene or carbon tetrachloride. The dried adhesive shall not omit nauseous, irritating, or toxic volatile matters or aerosols when the adhesive is heated to any temperature up to 212 degrees F. The adhesive shall be nonflammable and fire resistant.

2.1.3 Caulking

ASTM C 920, Type S, Grade NS, Class 25, Use A.

2.1.4 Corner Angles

Nominal 0.016 inch aluminum 1 x 1 inch with factory applied kraft backing. Aluminum shall be ASTM B 209, Alloy 3003, 3105, or 5005.

2.1.5 Finishing Cement

Mineral fiber hydraulic-setting thermal insulating cement ASTM C 449.

2.1.6 Fibrous Glass Cloth and Glass Tape

Fibrous glass cloth and glass tape shall have flame spread and smoke developed ratings of no greater than 25/50 when measured in accordance with ASTM E 84. Fibrous glass cloth and tape; 20 x 20 maximum size mesh. Tape shall be 4 inch wide rolls. Class 3 tape shall be 4.5 ounces per square yard.

2.1.7 Staples

Outward clinching type ASTM A 167, Type 304 or 316 stainless steel.

2.1.8 Jackets

ASTM C 921, Type I, maximum moisture vapor transmission 0.02 perms, minimum puncture resistance 50 Beach units on all surfaces except concealed ductwork, where a minimum puncture resistance of 25 Beach units is acceptable. Minimum tensile strength, 35 pound/inch width. ASTM C 921, Type II, minimum puncture resistance 25 Beach units, tensile strength minimum 20 pound/inch width. Jackets used on insulation exposed in finished areas shall have white finish suitable for painting without sizing.

2.1.8.1 White Vapor Retarder ASJ (All Service Jacket)

For use on hot/cold pipes, ducts, or equipment. Vapor retarder jackets used on insulation exposed in finished areas shall have white finish suitable for painting without sizing.

2.1.8.2 Aluminum Jackets

Aluminum jackets shall be corrugated, embossed or smooth sheet, 0.016 inch nominal thickness; ASTM B 209, Temper H14, Temper H16, Alloy 3003, 5005, or 3105 with factory applied moisture retarder. Corrugated aluminum jacket shall not be used outdoors. Aluminum jacket securing bands shall be Type 304 stainless steel, 0.015 inch thick, 1/2 inch wide for pipe under 12 inch diameter and 3/4 inch wide for pipe over 12 inch diameter. Aluminum jacket circumferential seam bands shall be 2 x 0.016 inch aluminum matching jacket material. Bands for insulation below ground shall be 3/4 x 0.020 inch thick stainless steel, or fiberglass reinforced tape. The jacket may, at the option of the Contractor, be provided with a factory fabricated Pittsburgh or "Z" type longitudinal joint. When the "Z" joint is used, the bands at the circumferential joints shall be designed by the manufacturer to seal the joints and hold the jacket in place.

2.1.8.3 Polyvinyl Chloride (PVC) Jackets

Polyvinyl chloride (PVC) jacket and fitting covers shall have high impact strength, UV resistant rating or treatment and moderate chemical resistance with minimum thickness 0.030 inch. Insulation under PVC jacket shall meet jacket manufacturer's written recommendations.

2.1.9 Vapor Retarder Coating

The vapor retarder coating shall be fire and water resistant and appropriately selected for either outdoor or indoor service. Color shall be white. The water vapor permeance of the compound shall not exceed 0.05 perm and shall be determined according to procedure B of ASTM E 96 utilizing apparatus described in ASTM E 96. The coating shall be a nonflammable, fire resistant type. The flash point of the compound shall not be less than 80 degrees F and shall be determined in accordance with ASTM D 3278. All other application and service properties shall be in accordance with ASTM C 647.

2.1.10 Wire

Soft annealed ASTM A 580 Type 302, 304 or 316 stainless steel, 16 or 18 gauge.

2.2 PIPE INSULATION MATERIALS

Pipe insulation materials shall be as follows:

2.2.1 Aboveground Cold Pipeline

Insulation for minus 30 degrees to plus 60 degrees F shall be as follows:

2.2.1.1 Cellular Glass

ASTM C 552, Type II, and Type III.

2.2.1.2 Flexible Cellular Insulation

ASTM C 534, Type I or II. Type II shall have vapor retarder skin on both sides of the insulation.

2.2.1.3 Phenolic Insulation

ASTM C 1126, Type III. A maximum allowable leachable chloride content shall comply with ASTM C 795 when tested in accordance with ASTM C 871.

2.2.2 Aboveground Hot Pipeline

For aboveground hot pipeline above 60 degrees F insulation the following requirements shall be met.

2.2.2.1 Mineral Fiber

ASTM C 547, Class 1 or Class 2 as required for the operating temperature range.

2.2.2.2 Calcium Silicate

ASTM C 533, Type I indoor only, or outdoors above 250 degrees F pipe temperature.

2.2.2.3 Cellular Glass

ASTM C 552, Type II and Type III.

2.2.2.4 Flexible Cellular Insulation

ASTM C 534, Type I or II to 200 degrees F service.

2.2.2.5 Phenolic Insulation

ASTM C 1126 Type III to 250 F service. A maximum allowable leachable chloride content shall comply with ASTM C 795 when tested in accordance with ASTM C 871.

2.2.3 Below ground Pipeline Insulation

ASTM C 552, Type II.

2.3 DUCT INSULATION MATERIALS

Duct insulation materials shall be as follows:

2.3.1 Rigid Mineral Fiber

ASTM C 612, Class 1.

2.3.2 Flexible Mineral Fiber

ASTM C 553, Type I, Class B-2.

2.3.3 Cellular Glass

ASTM C 552, Type I.

2.3.4 Phenolic Foam

ASTM C 1126 Type II. A maximum allowable leachable chloride content shall comply with ASTM C 795 when tested in accordance with ASTM C 871.

2.3.5 Flexible Cellular

ASTM C 534 Type II.

PART 3 EXECUTION

3.1 APPLICATION - GENERAL

3.1.1 Installation

Except as otherwise specified, material shall be installed in accordance with the manufacturer's written instructions. Insulation materials shall not be applied until tests and heat tracing specified in other sections of this specification are completed. Material such as rust, scale, dirt and moisture shall be removed from surfaces to receive insulation. Insulation shall be kept clean and dry. Insulation shall not be removed from its shipping containers until the day it is ready to use and shall be returned to like containers or equally protected from dirt and moisture at the end of each workday. Insulation that becomes dirty shall be thoroughly cleaned prior to use. If insulation becomes wet or if aforementioned cleaning does not restore the surfaces to like new condition, the insulation will be rejected, and shall be immediately removed from the jobsite. Joints shall be staggered on multi layer insulation. Mineral fiber thermal insulating cement shall be mixed with demineralized water when used on stainless steel surfaces. Insulation, jacketing and accessories shall be installed in accordance with MICA-01 standard plates except where modified herein or on the drawings.

3.1.2 Painting and Finishing

Painting shall be as specified in Section 09900 PAINTING, GENERAL.

3.1.3 Flexible Cellular Insulation

Flexible cellular insulation shall be installed with seams and joints sealed with a contact adhesive. Flexible cellular insulation shall not be used on surfaces greater than 200 degrees F. Seams shall be staggered when applying multiple layers of insulation. Insulation exposed to weather and not shown to have jacketing shall be protected with two coats of UV resistant finish as recommended by the manufacturer after the adhesive is dry.

3.1.4 Welding

No welding shall be done on piping, duct or equipment without written approval of the Contracting Officer. The capacitor discharge welding process may be used for securing metal fasteners to duct.

3.1.5 Pipes/Ducts/Equipment which Require Insulation

Insulation is required, unless stated otherwise, on all pipes, ducts, or equipment, which operate at or below 60 F and at or above 80 F.

3.2 PIPE INSULATION INSTALLATION

3.2.1 Pipe Insulation

3.2.1.1 General

Pipe insulation shall be installed on aboveground hot and cold pipeline systems as specified below to form a continuous thermal retarder, including straight runs, fittings and appurtenances unless specified otherwise. Installation shall be with full length units of insulation and using a single cut piece to complete a run. Cut pieces or scraps abutting each other shall not be used. Pipe insulation shall be omitted on the following:

- a. Pipe used solely for fire protection.
- b. Chromium plated pipe to plumbing fixtures. However, fixtures for use by the physically handicapped shall have the hot water supply and drain, including the trap, insulated where exposed.
- c. Sanitary drain lines.
- d. Unions in pipe above 60 degrees F.
- e. Strainers in pipe above 60 degrees F.
- f. Check valves in pipe above 60 degrees F.
- g. Air chambers.

3.2.1.2 Pipes Passing Through Sleeves

- a. Pipe insulation shall be continuous through the sleeve.
- b. An aluminum jacket with factory applied moisture retarder shall be provided over the insulation wherever penetrations require sealing.
- c. Where penetrating interior walls, the aluminum jacket shall extend 2 inches beyond either side of the wall and shall be secured on each end with a band.

- d. Where penetrating floors, the aluminum jacket shall extend from a point below the backup material to a point 10 inches above the floor with one band at the floor and one not more than 1 inch from the end of the aluminum jacket.
- e. In high abuse areas such as janitor closets and traffic areas in equipment rooms, kitchens, and mechanical rooms, aluminum jackets shall be utilized. Pipe insulation to the 5 ft level shall be protected.

3.2.1.3 Pipes Passing Through Hangers

- a. Insulation, whether hot or cold application, shall be continuous through hangers. All horizontal pipes 2 inches and smaller shall be supported on hangers with the addition of a Type 40 protection shield to protect the insulation in accordance with MSS SP-69. Whenever insulation shows signs of being compressed, or when the insulation or jacket shows visible signs of distortion at or near the support shield, insulation inserts as specified below for piping larger than 2 inches shall be installed.
- b. Horizontal pipes larger than 2 inches at 60 degrees F and above shall be supported on hangers in accordance with MSS SP-69, and Section 15400 PLUMBING, GENERAL PURPOSE.
- c. Horizontal pipes larger than 2 inches below 60 degrees F shall be supported on hangers with the addition of a Type 40 protection shield in accordance with MSS SP-69. An insulation insert of cellular glass or calcium silicate shall be installed above each shield. The insert shall cover not less than the bottom 180 degree arc of the pipe. Inserts shall be the same thickness as the insulation, and shall extend 2 inches on each end beyond the protection shield. When insulation inserts are required per the above, and the insulation thickness is less than 1 inch, wooden or cork dowels or blocks may be installed between the pipe and the shield to prevent the weight of the pipe from crushing the insulation as an option to installing insulation inserts. The insulation jacket shall be continuous over the wooden dowel, wooden block, or insulation insert.
- d. Vertical pipes shall be supported with either Type 8 or Type 42 riser clamps with the addition of two Type 40 protection shields in accordance with MSS SP-69 covering the 360 degree arc of the insulation. An insulation insert of cellular glass or calcium silicate shall be installed between each shield and the pipe. The insert shall cover the 360 degree arc of the pipe. Inserts shall be the same thickness as the insulation, and shall extend 2 inches on each end beyond the protection shield. When insulation inserts are required per the above, and the insulation thickness is less than 1 inch, wooden or cork dowels or blocks may be installed between the pipe and the shield to prevent the hanger from crushing the insulation as an option instead of installing insulation inserts. The insulation jacket shall be continuous over the wooden dowel, wooden block, or insulation insert. The vertical weight of the pipe shall be supported with hangers located in a horizontal section of the pipe. When the pipe riser is longer than 30 feet, the weight of the pipe shall be additionally supported with hangers in the vertical run of the pipe which are directly clamped to the pipe, penetrating the pipe insulation. These hangers shall be insulated and the insulation jacket sealed as indicated herein for anchors in a similar service.
- e. Inserts shall be covered with a jacket material of the same appearance and quality as the adjoining pipe insulation jacket, shall overlap the adjoining pipe jacket 1-1/2 inches, and shall be sealed as required for the pipe jacket. The jacket material used to cover inserts in

flexible cellular insulation shall conform to ASTM C 921, Type 1, and is allowed to be of a different material than the adjoining insulation material.

3.2.1.4 Pipes Passing Through Walls

- a. For hot water pipes supplying lavatories or other similar heated service which requires insulation, the insulation shall be terminated on the backside of the finished wall. The insulation termination shall be protected with two coats of vapor barrier coating with a minimum total thickness of 1/16 inch applied with glass tape embedded between coats (if applicable). The coating shall extend out onto the insulation 2 inches and shall seal the end of the insulation. Glass tape seams shall overlap 1 inch. Caulk the annular space between the pipe and wall penetration. Cover the pipe and wall penetration with a properly sized (well fitting) escutcheon plate. The escutcheon plate shall overlap the wall penetration at least 3/8 inch.
- b. For domestic cold water pipes requiring insulation, the insulation shall be terminated on the finished side of the wall (i.e. insulation must cover the pipe throughout the wall penetration). The insulation shall be protected with two coats of vapor barrier coating with a minimum total thickness of 1/16 inch. The coating shall extend out onto the insulation 2 inches and shall seal the end of the insulation. Caulk the annular space between the pipe and wall penetration. Cover the pipe and wall penetration with a properly sized (well fitting) escutcheon plate. The escutcheon plate shall overlap the wall penetration by at least 3/8 inch.

3.2.1.5 Flexible Cellular Pipe Insulation

Flexible cellular pipe insulation shall be tubular form for pipe sizes 6 inches and less. Type II sheet insulation used on pipes larger than 6 inches shall not be stretched around the pipe. On pipes larger than 12 inches, adhere insulation directly to the pipe on the lower 1/3 of the pipe. Seams shall be staggered when applying multiple layers of insulation. Sweat fittings shall be insulated with miter-cut pieces the same size as on adjacent piping. Screwed fittings shall be insulated with sleeved fitting covers fabricated from miter-cut pieces and shall be overlapped and sealed to the adjacent pipe insulation.

3.2.2 Aboveground Cold Pipelines

The following shall be included for aboveground cold pipelines minus 30 degrees to plus 60 degrees F:

- a. Domestic cold and chilled drinking water.
- b. Refrigerant suction lines.
- c. Air conditioner condensate drains.

3.2.2.1 Insulation Thickness

Insulation thickness for cold pipelines shall be determined using Table I.

Table I - Cold Piping Insulation Thickness
Pipe Size (inches)

Type of Service	Material	Runouts up to 2 in*	1 in & less	1.25 - 2 in	2.5 - 4 in	5 - 6 in	8 in & larger
Refrigerant suction piping	CG		1.5	1.5	1.5	1.5	1.5
	FC		1.0	1.0	1.0	1.0	1.0
	PF		1.0	1.0	1.0	1.0	1.0
Cold domestic water, above and below ceilings	CG	1.5	1.5	1.5	1.5	1.5	1.5
	FC	3/8	3/8	3/8	3/8	3/8	3/8
	PF	3/8	3/8	3/8	3/8	3/8	3/8
Air Conditioning condensate drain located inside building	FC		3/8	0.5	0.5	N/A	N/A
	PF		3/8	3/8	3/8	N/A	N/A

*When runouts to terminal units exceed 12 feet, the entire length of runout shall be insulated like main feed pipe.

LEGEND:

PF - Phenolic Foam
CG - Cellular Glass
CS - Calcium Silicate
MF - Mineral Fiber
FC - Flexible Cellular

3.2.2.2 Jacket for Fibrous, Cellular Glass, and Phenolic Foam Insulated Pipe

Insulation shall be covered with a factory applied vapor retarder jacket or field applied seal welded PVC jacket. Insulation inside the building shown to be protected with an aluminum jacket shall have the insulation and vapor retarder jacket installed as specified herein. The aluminum jacket shall be installed as specified for piping exposed to weather, except sealing of the laps of the aluminum jacket is not required. In high abuse areas such as janitor closets and traffic areas in equipment rooms, kitchens, and mechanical rooms, aluminum jackets shall be utilized. Pipe insulation to the 5 ft level will be protected.

3.2.2.3 Insulation for Straight Runs (Fibrous, Cellular Glass and Phenolic Foam)

- a. Insulation shall be applied to the pipe with joints tightly butted. The ends of fibrous insulation shall be sealed off with vapor retarder coating at intervals not to exceed 15 feet.
- b. Longitudinal laps of the jacket material shall overlap not less than 1-1/2 inches. Butt strips 3 inches wide shall be provided for circumferential joints.

- c. Laps and butt strips shall be secured with adhesive and stapled on 4 inch centers if not factory self-sealing.
- d. Factory self-sealing lap systems may be used when the ambient temperature is between 40 degrees and 120 degrees F during installation. The lap system shall be installed in accordance with manufacturer's recommendations. Stapler shall be used only if specifically recommended by the manufacturer. Where gaps occur, the section shall be replaced or the gap repaired by applying adhesive under the lap and then stapling.
- e. All staples, including those used to repair factory self-seal lap systems, shall be coated with a vapor retarder coating. All seams, except those on factory self-seal systems shall be coated with vapor retarder coating.
- f. Breaks and punctures in the jacket material shall be patched by wrapping a strip of jacket material around the pipe and securing it with adhesive, stapling, and coating with vapor retarder coating. The patch shall extend not less than 1-1/2 inches past the break.
- g. At penetrations such as thermometers, the voids in the insulation shall be filled and sealed with vapor retarder coating.

3.2.2.4 Insulation for Fittings and Accessories

- a. Pipe insulation shall have ends thoroughly coated with a vapor retarder coating not less than 6 inches from each flange, union, valve, anchor, or fitting in all directions.
- b. Precut, preformed insulation for placement over fittings, flanges, unions, valves, anchors, and mechanical couplings shall be used. Precut, preformed insulation shall exhibit the same properties as the adjoining pipe insulation. Where precut/preformed is unavailable, rigid preformed pipe insulation sections may be segmented into the shape required. Insulation of the same thickness and conductivity as the adjoining pipe insulation shall be used. If nesting size insulation is used, the insulation should be overlapped 2 inches or one pipe diameter. Loose fill mineral fiber or insulating cement shall be used to fill the voids. Elbows insulated using segments shall not have less than 3 segments per elbow.
- c. Upon completion of installation of insulation on flanges, unions, valves, anchors, fittings and accessories, terminations and insulation not protected by factory vapor retarder jackets or PVC fitting covers shall be protected with two coats of vapor retarder coating with a minimum total thickness of 1/16 inch, applied with glass tape embedded between coats. Tape seams shall overlap 1 inch. The coating shall extend out onto the adjoining pipe insulation 2 inches.
- d. Anchors attached directly to the pipe shall be insulated for a sufficient distance to prevent condensation but not less than 6 inches from the insulation surface.
- e. Flexible connections at pumps and other equipment shall be insulated with 1 inch flexible cellular insulation, unless otherwise indicated.
- f. Insulation shall be marked showing the location of unions, strainers, and check valves.

3.2.2.5 Optional PVC Fitting Covers

At the option of the Contractor, premolded, one or two piece PVC fitting covers may be used in lieu of the vapor retarder and embedded glass tape. Factory premolded insulation segments shall be used under the fitting covers for elbows. Insulation segments shall be the same thickness as adjoining pipe insulation and the insulation shall be protected with one coat of vapor retarder coating under the PVC cover. The covers shall be secured by PVC vapor retarder tape, adhesive, seal-welding or with tacks made for securing PVC covers. Seams in the cover, and tacks and laps to adjoining pipe insulation jacket, shall be sealed with vapor retarder tape to ensure that the assembly has a continuous vapor seal.

3.2.3 Aboveground Hot Pipelines

For hot pipelines above 60 degrees F the following shall be included:

- a. Domestic hot water.

3.2.3.1 Insulation Thickness

Insulation thickness for hot pipelines shall be determined using Table II.

LEGEND:

PF - Phenolic Foam
CG - Cellular Glass
CS - Calcium Silicate
MF - Mineral Fiber
FC - Flexible Cellular

Table II - Hot Piping Insulation Thickness
Pipe Size (inches)

Type of Service (degrees F)	Material	Runouts up to 2 in	1 in & less	1.25 - 2 in	2.5 - 4 in	5 - 6 in	8 in & larger
Hot domestic water supply & recirculating system (200 F max)	CG	1.5	1.5	1.5	1.5	1.5	1.5
	FC	0.5	1.0	1.0	1.5	1.5	1.5
	PF	0.5	1.0	1.0	1.0	1.0	1.0
	MF	0.5	1.0	1.0	1.5	1.5	1.5

*When runouts to terminal units exceed 12 feet, the entire length of runout shall be insulated like the main feed pipe.

3.2.3.2 Jacket for Insulated Pipe

Insulation shall be covered, in accordance with manufacturer's recommendations, with a factory applied Type II jacket or field applied aluminum where required or seal welded PVC.

3.2.3.3 Insulation for Straight Runs

- a. Insulation shall be applied to the pipe with joints tightly butted.
- b. Longitudinal laps of the jacket material shall overlap not less than 1-1/2 inches, and butt strips 3 inches wide shall be provided for circumferential joints.
- c. Laps and butt strips shall be secured with adhesive and stapled on 4 inch centers if not factory self-sealing. Adhesive may be omitted where pipe is concealed.
- d. Factory self-sealing lap systems may be used when the ambient temperature is between 40 degrees and 120 degrees F and shall be installed in accordance with manufacturer's instructions. Laps and butt strips shall be stapled whenever there is nonadhesion of the system. Where gaps occur, the section shall be replaced or the gap repaired by applying adhesive under the lap and then stapling.
- e. Breaks and punctures in the jacket material shall be patched by wrapping a strip of jacket material around the pipe and be secured with adhesive and stapled on 4 inch centers if not factory self-sealing. Adhesive may be omitted where pipe is concealed. Patch shall extend not less than 1-1/2 inches past the break.
- f. Install flexible cellular pipe insulation by slitting tubular sections and applying onto piping or tubing. Alternately, whenever possible, slide unslit sections over the open ends of piping or tubing. All seams and butt joints shall be secured and sealed with adhesive. When using self seal products only the butt joints shall be secured with adhesive. Insulation shall be pushed on the pipe, never pulled. Stretching of insulation may result in open seams and joints. All edges shall be clean cut. Rough or jagged edges of the insulation shall not be permitted. Proper tools such as sharp knives must be used. Type II sheet insulation when used on pipe larger than 6 inches shall not be stretched around the pipe. On pipes larger than 12 inches, adhere sheet insulation directly to the pipe on the lower 1/3 of the pipe.

3.2.3.4 Insulation for Fittings and Accessories

- a. The run of the line pipe insulation shall have the ends brought up to the item.
- b. Insulation of the same thickness and conductivity as the adjoining pipe insulation, either premolded or segmented, shall be placed around the item abutting the adjoining pipe insulation, or if nesting size insulation is used, overlapping 2 inches or one pipe diameter. Loose fill mineral fiber or insulating cement shall be used to fill the voids. Insulation for elbows less than 3 inch size shall be premolded. Insulation for elbows 3 inch size and larger shall be either premolded or segmented. Elbows insulated using segments shall have not less than 3 segments per elbow. Insulation may be wired or taped on until finish is applied.
- c. Upon completion of installation of insulation on flanges, unions, valves, anchors, fittings and accessories, terminations and insulation not protected by factory vapor retarder jackets or PVC fitting covers shall be protected with two coats of Class 1 adhesive applied with glass tape embedded between coats. Tape seams shall overlap 1 inch. Adhesive shall extend onto the adjoining insulation not less than 2 inches. The total dry film thickness shall be not less than 1/16 inch.

- d. Insulation terminations shall be tapered to unions at a 45-degree angle.
- e. At the option of the Contractor, factory premolded one- or two-piece PVC fitting covers may be used in lieu of the adhesive and embedded glass tape. Factory premolded segments or factory or field cut blanket insert insulation segments shall be used under the cover and shall be the same thickness as adjoining pipe insulation. The covers shall be secured by PVC vapor retarder tape, adhesive, seal-welding or with tacks made for securing PVC covers.

3.2.4 Piping Exposed to Weather

Piping exposed to weather shall be insulated and jacketed as specified for the applicable service inside the building. After this procedure, an aluminum jacket shall be applied. PVC jacketing requires no factory applied jacket beneath it. Flexible cellular insulation exposed to weather shall be treated in accordance with paragraph FLEXIBLE CELLULAR INSULATION.

3.2.4.1 Aluminum Jacket

The jacket for hot piping may be factory applied. The jacket shall overlap not less than 2 inches at longitudinal and circumferential joints and shall be secured with bands at not more than 12 inch centers. Longitudinal joints shall be overlapped down to shed water and located at 4 or 8 o'clock positions. Joints on piping 60 degrees F and below shall be sealed with caulking while overlapping to prevent moisture penetration. Where jacketing on piping 60 degrees F and below abuts an uninsulated surface, joints shall be caulked to prevent moisture penetration. Joints on piping above 60 degrees F shall be sealed with a moisture retarder.

3.2.4.2 Insulation for Fittings

Flanges, unions, valves, fittings, and accessories shall be insulated and finished as specified for the applicable service. Two coats of an emulsion type weatherproof mastic recommended by the insulation manufacturer shall be applied with glass tape embedded between coats. Tape overlaps shall be not less than 1 inch and the adjoining aluminum jacket not less than 2 inches. Factory preformed aluminum jackets may be used in lieu of the above. Molded PVC fitting covers shall be used with PVC lagging and adhesive welded moisture tight.

3.2.4.3 PVC Lagging

PVC lagging shall be ultraviolet resistant and adhesive welded vapor tight with manufacturer's recommended adhesive. Installation shall include provision for thermal expansion.

3.3 DUCT INSULATION INSTALLATION

Except for oven hood exhaust duct insulation, corner angles shall be installed on external corners of insulation on ductwork in exposed finished spaces before covering with jacket.

3.3.1 Duct Insulation Thickness

Duct insulation thickness shall be in accordance with Table III.

Table III - Minimum Duct Insulation (mm)

Cold Air Ducts	50
Relief Ducts	38
Fresh Air Intake Ducts	38
Warm Air Ducts	50
Relief Ducts	38
Fresh Air Intake Ducts	38

Table III - Minimum Duct Insulation (inches)

Cold Air Ducts	2.0
Relief Ducts	1.5
Fresh Air Intake Ducts	1.5
Warm Air Ducts	2.0
Relief Ducts	1.5
Fresh Air Intake Ducts	1.5

3.3.2 Insulation and Vapor Retarder for Cold Air Duct

Insulation and vapor retarder for cold air duct below 60 degrees F: Ducts and associated equipment shall be insulated to a thickness which is in accordance with Table III. The following shall be insulated:

- a. Supply ducts.
- b. Return air ducts.

Insulation for rectangular ducts shall be flexible type where concealed, minimum density 3/4 pcf and rigid type where exposed, minimum density 3 pcf. Insulation for round/oval ducts shall be flexible type, minimum density 3/4 pcf with a factory Type I jacket; or, a semi rigid board, minimum density 3 pcf, formed or fabricated to a tight fit, edges beveled and joints tightly butted and staggered, with a factory applied Type I all service jacket. Insulation for exposed ducts shall be provided with either a white, paintable, factory-applied Type I jacket or a vapor retarder jacket coating finish as specified. Fibrous and cellular glass insulation on concealed duct shall be provided with a factory-applied Type I vapor retarder jacket. The total dry film thickness shall be approximately 1/16 inch. Duct insulation shall be continuous through sleeves and prepared openings except fire wall penetrations. Duct insulation terminating at fire dampers, shall be continuous over the damper collar and retaining angle of fire dampers, which are exposed to unconditioned air and which may be prone to condensate formation. Duct insulation and vapor retarder shall cover the collar, neck, and any uninsulated surfaces of diffusers, registers and grills. Vapor retarder materials shall be applied to form a complete unbroken vapor seal over the insulation.

3.3.2.1 Installation on Concealed Duct

- a. For rectangular, oval or round ducts, insulation shall be attached by applying Class 2 adhesive around the entire perimeter of the duct in 6 inch wide strips on 12 inch centers.
- b. For rectangular and oval ducts, 24 inches and larger insulation shall be additionally secured to bottom of ducts by the use of mechanical fasteners. Fasteners shall be spaced on 18 inch centers and not more than 18 inches from duct corners.
- c. For rectangular, oval and round ducts, mechanical fasteners shall be provided on sides of duct risers for all duct sizes. Fasteners shall be spaced on 18 inch centers and not more than 18 inches from duct corners.
- d. Insulation shall be impaled on the mechanical fasteners where used and shall be pressed thoroughly into the adhesive. Care shall be taken to ensure vapor retarder jacket joints overlap 2 inches. The insulation shall not be compressed to a thickness less than that specified. Insulation shall be carried over standing seams and trapeze-type duct hangers.
- e. Self-locking washers shall be installed where mechanical fasteners are used. The pin shall be trimmed back and bent over.
- f. Jacket overlaps shall be secured under the overlap with Class 2 adhesive and stapled on 4 inch centers. Staples and seams shall be coated with a brush coat of vapor retarder coating.
- g. Breaks in the jacket material shall be covered with patches of the same material as the vapor retarder. The patches shall extend not less than 2 inches beyond the break or penetration in all directions and shall be secured with Class 2 adhesive and staples. Staples and joints shall be sealed with a brush coat of vapor retarder coating.
- h. At jacket penetrations such as hangers thermometers and damper operating rods, voids in the insulation shall be filled and the penetration sealed with a brush coat of vapor retarder coating.
- i. Insulation terminations and pin punctures shall be sealed and flashed with a reinforced vapor retarder coating finish. The coating shall overlap the adjoining insulation and uninsulated surface 2 inches. Pin puncture coatings shall extend 2 inches from the puncture in all directions.
- j. Where insulation standoff brackets occur, insulation shall be extended under the bracket and the jacket terminated at the bracket.

3.3.2.2 Installation on Exposed Duct Work

- a. For rectangular ducts, rigid insulation shall be secured to the duct by mechanical fasteners on all four sides of the duct, spaced not more than 12 inches apart and not more than 3 inches from the edges of the insulation joints. A minimum of two rows of fasteners shall be provided for each side of duct 12 inches and larger. One row shall be provided for each side of duct less than 12 inches.
- b. Duct insulation shall be formed with minimum jacket seams. Each piece of rigid insulation shall be fastened to the duct using mechanical fasteners. When the height of projections is

less than the insulation thickness, insulation shall be brought up to standing seams, reinforcing, and other vertical projections and shall not be carried over. Vapor retarder jacket shall be continuous across seams, reinforcing, and projections. When height of projections is greater than the insulation thickness, insulation and jacket shall be carried over.

- c. Insulation shall be impaled on the fasteners; self-locking washers shall be installed and the pin trimmed and bent over.
- d. Joints in the insulation jacket shall be sealed with a 4 inch wide strip of the same material as the vapor retarder jacket. The strip shall be secured with Class 2 adhesive and stapled. Staples and seams shall be sealed with a brush coat of vapor retarder coating.
- e. Breaks and ribs or standing seam penetrations in the jacket material shall be covered with a patch of the same material as the jacket. Patches shall extend not less than 2 inches beyond the break or penetration and shall be secured with Class 2 adhesive and stapled. Staples and joints shall be sealed with a brush coat of vapor retarder coating.
- f. At jacket penetrations such as hangers, thermometers, and damper operating rods, the voids in the insulation shall be filled and the penetrations sealed with a brush coat of vapor retarder coating.
- g. Insulation terminations and pin punctures shall be sealed and flashed with a reinforced vapor retarder coating finish. The coating shall overlap the adjoining insulation and uninsulated surface 2 inches. Pin puncture coatings shall extend 2 inches from the puncture in all directions.
- h. Oval and round ducts, flexible type, shall be insulated with factory Type I jacket insulation with minimum density of 3/4 pcf attached by applying Class 2 adhesive around the entire perimeter of the duct in 6 inch wide strips on 12 inch centers.

3.3.3 Insulation for Warm Air Duct

For warm air ducts above 60 degrees F, ducts and associated equipment shall be insulated to a thickness which is in accordance with Table III. The following shall be insulated:

- a. Supply ducts.
- b. Return air ducts.

Insulation for rectangular ducts shall be flexible type where concealed, minimum density 3/4 pcf; and rigid type where exposed, minimum density 3 pcf. Insulation on exposed ducts shall be provided with a white, paintable, factory-applied Type II jacket, or finished with Class 1 adhesive finish. Flexible type insulation shall be used for round ducts, minimum density 3/4 pcf with a factory-applied Type II jacket. Insulation on concealed duct shall be provided with a factory-applied Type II jacket. Class 1 adhesive finish where indicated to be used shall be accomplished by applying two coats of Class 1 adhesive with a layer of glass cloth embedded between the coats. The total dry film thickness shall be approximately 1/16 inch. Duct insulation shall be continuous through sleeves and prepared openings. Duct insulation shall terminate at fire dampers and flexible connections.

3.3.3.1 Installation on Concealed Duct

- a. For rectangular, oval and round ducts, insulation shall be attached by applying Class 2 adhesive around the entire perimeter of the duct in 6 inch wide strips on 12 inch centers.
- b. For rectangular and oval ducts 24 inches and larger, insulation shall be secured to the bottom of ducts by the use of mechanical fasteners. Fasteners shall be spaced on 18 inch centers and not more than 18 inches from duct corner.
- c. For rectangular, oval and round ducts, mechanical fasteners shall be provided on sides of duct risers for all duct sizes. Fasteners shall be spaced on 18 inch centers and not more than 18 inches from duct corners.
- d. The insulation shall be impaled on the mechanical fasteners where used and shall be pressed thoroughly into the adhesive. The insulation shall not be compressed to a thickness less than that specified. Insulation shall be carried over standing seams and trapeze-type hangers.
- e. Self-locking washers shall be installed where mechanical fasteners are used and the pin trimmed and bent over.
- f. Insulation jacket shall overlap not less than 2 inches at joints and the lap shall be secured with Class 2 adhesive under the lap and stapled on 4 inch centers.

3.3.3.2 Installation on Exposed Duct

- a. For rectangular ducts, the rigid insulation shall be secured to the duct by the use of mechanical fasteners on all four sides of the duct, spaced not more than 12 inches apart and not more than 3 inches from the edges of the insulation joints. A minimum of two rows of fasteners shall be provided for each side of duct 12 inches and larger and a minimum of one row for each side of duct less than 12 inches.
- b. Duct insulation with factory-applied jacket shall be formed with minimum jacket seams, and each piece of rigid insulation shall be fastened to the duct using mechanical fasteners. When the height of projection is less than the insulation thickness, insulation shall be brought up to standing seams, reinforcing, and other vertical projections and shall not be carried over the projection. Jacket shall be continuous across seams, reinforcing, and projections. Where the height of projections is greater than the insulation thickness, insulation and jacket shall be carried over the projection.
- c. Insulation shall be impaled on the fasteners; self-locking washers shall be installed and pin excess clipped and bent over.
- d. Joints on jacketed insulation shall be sealed with a 4 inch wide strip of the same material as the jacket. The strip shall be secured with Class 2 adhesive and stapled.
- e. Breaks and penetrations in the jacket material shall be covered with a patch of the same material as the jacket. Patches shall extend not less than 2 inches beyond the break or penetration and shall be secured with Class 2 adhesive and stapled.

- f. Insulation terminations and pin punctures shall be sealed and flashed with a Class 1 adhesive. Two coats of Class 1 adhesive coating shall be applied with glass cloth embedded between coats. The total coating shall have a dry film thickness of approximately 1/16 inch and shall overlap the adjoining insulation and uninsulated surface 2 inches.
- g. Oval and round ducts, flexible type, shall be insulated with factory Type I jacket insulation, minimum density of 3/4 pcf attached by applying Class 2 adhesive around the entire perimeter of the duct in 6 inch wide strips on 12 inch center. Joints shall be sealed with a 4 inch wide strip of the same material as the jacket. The strip shall be secured with Class 2 adhesive and stapled.

3.3.4 Ducts Handling Air for Dual Purpose

For air handling ducts for dual purpose below and above 60 degrees F, ducts shall be insulated as specified for cold air duct.

3.3.5 Duct Test Holes

After duct systems have been tested, adjusted, and balanced, breaks in the insulation and jacket shall be repaired in accordance with the applicable section of this specification for the type of duct insulation to be repaired.

End of Section

DIVISION 15 - MECHANICAL

SECTION 15400

PLUMBING, GENERAL PURPOSE

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PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 74	(1996) Cast Iron Soil Pipe and Fittings
ASTM A 105	(1997) Forgings, Carbon Steel, for Piping Components
ASTM A 193	(1997a) Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
ASTM A 515	(1992)e1 Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service
ASTM A 516	(1996) Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service
ASTM B 813	(1993) Liquid and Paste Fluxes for Soldering Applications of Copper and Copper Alloy Tube
ASTM C 564	(1997) Rubber Gaskets for Cast Iron Soil Pipe and Fittings
ASTM C 920	(1998) Elastomeric Joint Sealants
ASTM D 2564	(1996a) Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D 2822	(1997)e1 Asphalt Roof Cement
ASTM D 2855	(1996) Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings
ASTM D 3139	(1996a) Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
ASTM D 3212	(1996a) Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM D 3308	(1997) PTFE Resin Skived Tape

ASTM D 3311 (1994) Drain, Waste, and Vent (DWV) Plastic Fittings Patterns

ASTM F 409 (1997) Thermoplastic Accessible and Replaceable Plastic Tube and Tubular Fittings

ASTM F 477 (1996a) Elastomeric Seals (Gaskets) for Joining Plastic Pipe

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 90.1 (1989; 90.1b; 90.1c; 90.1d; 90.1e; 90.1g; 90.1i) Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A112.6.1M (1997) Supports for Off-the-Floor Plumbing Fixtures for Public Use

ASME A112.19.1M (1994) Enameled Cast Iron Plumbing Fixtures

ASME A112.19.2M (1998) Vitreous China Plumbing Fixtures

ASME A112.21.1M (R1998) Floor Drains

ASME A112.36.2M (R1998) Cleanouts

ASME B1.20.1 (1983; R 1992) Pipe Threads, General Purpose (Inch)

ASME B16.5 (1996; Errata Oct 88; B16.5a) Pipe Flanges and Flanged Fittings

ASME B16.21 (1992) Nonmetallic Flat Gaskets for Pipe Flanges

ASME B16.34 (1996) Valves - Flanged, Threaded, and Welding End

ASME B31.1 (1998) Power Piping

ASME B31.5 (1992; B31.5a) Refrigeration Piping

ASME B40.1 (1991) Gauges - Pressure Indicating Dial Type - Elastic Element

ASME BPV VIII Div 1 (1998) Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels Division 1 - Basic Coverage

ASME BPV IX (1995; Addenda Dec 1995) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1001	(1990) Pipe Applied Atmospheric Type Vacuum Breakers
ASSE 1003	(1995; Rev thru Oct 1993; Errata Dec 1993) Water Pressure Reducing Valves for Domestic Water Supply Systems
ASSE 1005	(1993) Water Heater Drain Valves - 3/4-Inch Iron Pipe Size
ASSE 1037	(1986; Rev thru Mar 1990) Pressurized Flushing Devices (Flushometers) for Plumbing Fixtures/F

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA-01	(1995) Standard Methods for the Examination of Water and Wastewater
AWWA B300	(1992) Hypochlorites
AWWA B301	(1992) Liquid Chlorine
AWWA C105	(1993) Polyethylene Encasement for Ductile-Iron Pipe Systems
AWWA C203	(1991) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied
AWWA C606	(1987) Grooved and Shouldered Joints
AWWA M20	(1973) Manual: Water Chlorination Principles and Practices

AMERICAN WELDING SOCIETY (AWS)

AWS A5.8	(1992) Filler Metals for Brazing and Braze Welding
AWS B2.2	(1991) Brazing Procedure and Performance Qualification

CAST IRON SOIL PIPE INSTITUTE (CISPI)

CISPI HSN-85	(1985) Neoprene Rubber Gaskets for Hub and Spigot Cast Iron Soil Pipe and Fittings
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CODE OF FEDERAL REGULATIONS (CFR)

10 CFR 430	Energy Conservation Program for Consumer Products
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COMMERCIAL ITEM DESCRIPTIONS (CID)

CID A-A-238	(Rev B) Seat, Water Closet
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COPPER DEVELOPMENT ASSOCIATION (CDA)

CDA-02 (1995) Copper Tube Handbook

INTERNATIONAL CODE COUNCIL/AMERICAN NATIONAL
STANDARDS INSTITUTE (ICC/ANSI)

ICC/ANSI A117.1 (1998) Accessible and Usable Buildings and Facilities

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS
INDUSTRY (MSS)

MSS SP-25 (1993) Standard Marking System for Valves, Fittings,
Flanges and Unions

MSS SP-58 (1993) Pipe Hangers and Supports - Materials, Design and
Manufacture

MSS SP-69 (1996) Pipe Hangers and Supports - Selection and
Application

MSS SP-70 (1990) Cast Iron Gate Valves, Flanged and Threaded Ends

MSS SP-71 (1990) Cast Iron Swing Check Valves, Flanges and Threaded
Ends

MSS SP-73 (1991) Brazing Joints for Copper and Copper Alloy Pressure
Fittings

MSS SP-80 (1997) Bronze Gate, Globe, Angle and Check Valves

MSS SP-110 (1996) Ball Valves Threaded, Socket-Welding, Solder Joint,
Grooved and Flared Ends

NATIONAL ASSOCIATION OF PLUMBING-HEATING-COOLING CONTRACTORS
(NAPHCC)

NAPHCC-01 (1996) National Standard Plumbing Code

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250 (1997) Enclosures for Electrical Equipment (1000 Volts
Maximum)

NSF INTERNATIONAL (NSF)

NSF Std 14 (1965; Rev Nov 1990) Plastics Piping Components and
Related Materials

PLASTIC PIPE AND FITTINGS ASSOCIATION (PPFA)

PPFA-01 (1991) Plastic Pipe in Fire Resistive Construction

PLUMBING AND DRAINAGE INSTITUTE (PDI)

PDI WH 201 (1992) Water Hammer Arresters

UNDERWRITERS LABORATORIES (UL)

UL 174 (1996) Household Electric Storage Tank Water Heaters

1.2 STANDARD PRODUCTS

Specified materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacture of such products. Specified equipment shall essentially duplicate equipment that has performed satisfactorily at least two years prior to bid opening.

1.3 PERFORMANCE REQUIREMENTS

1.3.1 Welding

Piping shall be welded in accordance with qualified procedures using performance-qualified welders and welding operators. Procedures and welders shall be qualified in accordance with ASME BPV IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer, may be accepted as permitted by ASME B31.1. The Contracting Officer shall be notified 24 hours in advance of tests, and the tests shall be performed at the work site if practicable. Welders or welding operators shall apply their assigned symbols near each weld they make as a permanent record.

1.4 ELECTRICAL WORK

Motors, motor controllers and motor efficiencies shall conform to the requirements of Section 16415 ELECTRICAL WORK, INTERIOR. Electrical motor-driven equipment specified herein shall be provided complete with motors. Equipment shall be rated at 60 Hz, single phase, ac unless otherwise indicated. Where a motor controller is not provided in a motor-control center on the electrical drawings, a motor controller shall be as indicated. Motor controllers shall be provided complete with properly sized thermal-overload protection in each ungrounded conductor, auxiliary contact, and other equipment, at the specified capacity, and including an allowable service factor.

1.5 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Welding; FIO.

A copy of qualified procedures and a list of names and identification symbols of qualified welders and welding operators.

SD-04 Drawings

Plumbing System; FIO.

Detail drawings consisting of illustrations, schedules, performance charts, instructions, brochures, diagrams, and other information to illustrate the requirements and operations of each system. Detail drawings for the complete plumbing system including piping layouts and locations of connections; dimensions for roughing-in, foundation, and support points; schematic diagrams and wiring diagrams or connection and interconnection diagrams. Detail drawings shall indicate clearances required for maintenance and operation. Where piping and equipment are to be supported other than as indicated, details shall include loadings and proposed support methods. Mechanical drawing plans, elevations, views, and details, shall be drawn to scale.

Electrical Schematics; FIO.

Complete electrical schematic lineless or full line interconnection and connection diagram for each piece of mechanical equipment having more than one automatic or manual electrical control device.

SD-06 Instructions

Plumbing System; FIO.

Diagrams, instructions, and other sheets proposed for posting. Manufacturer's recommendations for the installation of bell and spigot and hubless joints for cast iron soil pipe.

SD-09 Reports

Tests, Flushing and Sterilization; GA.

Test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, completion and testing of the installed system. Each test report shall indicate the final position of controls.

SD-13 Certificates

Materials and Equipment; FIO.

Where materials or equipment are specified to comply with requirements of AGA, or ASME, proof of such compliance. The label or listing of the specified agency will be acceptable evidence. In lieu of the label or listing, a written certificate may be submitted from an approved, nationally recognized testing organization equipped to perform such services, stating that the items have been tested and conform to the requirements and testing methods of the specified agency. Where equipment is specified to conform to requirements of the ASME Boiler and Pressure Vessel Code, the design, fabrication, and installation shall conform to the code.

Bolts; GA.

Written certification by the bolt manufacturer that the bolts furnished comply with the specified requirements. The certification shall include illustrations of product-required markings, the date of manufacture, and the number of each type of bolt to be furnished based on this certification.

SD-19 Operation and Maintenance Manuals

Plumbing System; GA.

Six (6) copies of the operation manual outlining the step-by-step procedures required for system startup, operation and shutdown. The manual shall include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. Six (6) copies of the maintenance manual listing routine maintenance procedures, possible breakdowns and repairs. The manual shall include piping and equipment layout and simplified wiring and control diagrams of the system as installed.

1.6 REGULATORY REQUIREMENTS

1.6.1 Plumbing

Plumbing work shall be in accordance with NAPHCC-01.

1.7 PROJECT/SITE CONDITIONS

The Contractor shall become familiar with details of the work, verify dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

PART 2 PRODUCTS

2.1 MATERIALS

Soil, waste, and vent piping below the operating floor (Elev. 306.0) shall be hubless or bell and spigot cast iron. Concealed soil, waste, and vent piping above the operating floor may be PVC. Exposed vent piping above the office area shall be either threaded cast iron or steel piping. Above ground water piping less than 1" shall be copper and over 1" shall be either copper or galvanized steel. Underground water piping shall be copper. Compressed air piping shall be galvanized steel. Pipe schedules shall be selected based on service requirements. Pipe fittings shall be compatible with the applicable pipe materials. Plastic pipe, fittings, and solvent cement shall meet NSF Std 14 and shall be NSF listed for the service intended. Plastic pipe, fittings, and solvent cement used for potable hot and cold water service shall bear the NSF seal "NSF-PW." Pipe threads (except dry seal) shall conform to ASME B1.20.1. Material or equipment containing lead shall not be used in any potable water system.

2.1.1 Pipe Joint Materials

Joints and gasket materials shall conform to the following:

- a. Coupling for Cast-Iron Pipe: ASTM A 74, AWWA C606.
- b. Coupling for Steel Pipe: AWWA C606.
- c. Flange Gaskets: Gaskets shall be made of non-asbestos material in accordance with ASME B16.21. Gaskets shall be flat, 1/16 inch thick, and contain Aramid fibers bonded with Styrene Butadiene Rubber (SBR) or Nitro Butadiene Rubber (NBR). Gaskets shall be the full face or self centering flat ring type. Gaskets used for hydrocarbon service shall be bonded with NBR.

- d. Neoprene Gaskets for Hub and Cast-Iron Pipe and Fittings: CISPI HSN-85.
- e. Brazing Material: Brazing material shall conform to AWS A5.8, BCuP-5.
- f. Brazing Flux: Flux shall be in paste or liquid form appropriate for use with brazing material. Flux shall be as follows: lead-free; have a 100 percent flushable residue; contain slightly acidic reagents; contain potassium borides; and contain fluorides. Silver brazing materials shall be in accordance with AWS A5.8.
- g. Solder Material: Solder metal shall conform to ASTM B 32 95-5 tin-antimony.
- h. Solder Flux: Flux shall be liquid form, non-corrosive, and conform to ASTM B 813, Standard Test 1.
- i. PTFE Tape: PTFE Tape, for use with Threaded Metal or Plastic Pipe, ASTM D 3308.
- j. Rubber Gaskets for Cast-Iron Soil-Pipe and Fittings: ASTM C 564.
- k. Flexible Elastomeric Seals: ASTM D 3139, ASTM D 3212 or ASTM F 477.
- l. Plastic Solvent Cement for PVC Plastic Pipe: ASTM D 2564 and ASTM D 2855.
- m. Flanged fittings including flanges, bolts, nuts, bolt patterns, etc. shall be in accordance with ASME B16.5 class 150 and shall have the manufacturer's trademark affixed in accordance with MSS SP-25. Flange material shall conform to ASTM A 105. Blind flange material shall conform to ASTM A 516 cold service and ASTM A 515 for hot service. Bolts shall be high strength or intermediate strength with material conforming to ASTM A 193.

2.1.2 Miscellaneous Materials

Miscellaneous materials shall conform to the following:

- a. Water Hammer Arrestor: PDI WH 201.
- b. Asphalt Roof Cement: ASTM D 2822.
- c. Supports for Off-The-Floor Plumbing Fixtures: ASME A112.6.1M.
- d. Metallic Cleanouts: ASME A112.36.2M.
- e. Plumbing Fixture Setting Compound: A preformed flexible ring seal molded from hydrocarbon wax material. The seal material shall be nonvolatile nonasphaltic and contain germicide and provide watertight, gastight, odorproof and verminproof properties.
- f. Hypochlorites: AWWA B300.
- g. Liquid Chlorine: AWWA B301.
- h. Polyethylene Encasement for Ductile-Iron Piping: AWWA C105.

- i. Gauges - Pressure and Vacuum Indicating Dial Type - Elastic Element: ASME B40.1.

2.1.3 Pipe Insulation Material

Insulation shall be as specified in Section 15250 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.2 PIPE HANGERS, INSERTS, AND SUPPORTS

Pipe hangers, inserts, and supports shall conform to MSS SP-58 and MSS SP-69.

2.3 VALVES

Valves shall be provided on supplies to equipment and fixtures. Valves 2-1/2 inches and smaller shall be bronze with threaded bodies for pipe and solder-type connections for tubing. Valves 3 inches and larger shall have flanged iron bodies and bronze trim. Pressure ratings shall be based upon the application. Grooved end valves may be provided if the manufacturer certifies that the valves meet the performance requirements of applicable MSS standard. Valves shall conform to the following standards:

<u>Description</u>	<u>Standard</u>
Cast-Iron Gate Valves, Flanged and Threaded Ends	MSS SP-70
Cast-Iron Swing Check Valves, Flanged and Threaded Ends	MSS SP-71
Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends	MSS SP-110
Bronze Gate, Globe, Angle, and Check Valves	MSS SP-80
Steel Valves, Socket Welding and Threaded Ends	ASME B16.34
Vacuum Relief Valves	ASSE 1001
Water Pressure Reducing Valves	ASSE 1003
Water Heater Drain Valves	ASSE 1005

2.3.1 Wall Faucets

Wall faucets with vacuum-breaker backflow preventer shall be brass with 3/4 inch male inlet threads, hexagon shoulder, and 3/4 inch hose connection. Faucet handle shall be securely attached to stem.

2.3.2 Relief Valves

Water heaters and hot water storage tanks shall have a combination pressure and temperature (P&T) relief valve. The pressure relief element of a P&T relief valve shall have adequate capacity to prevent excessive pressure buildup in the system when the system is operating at the maximum rate of heat

input. The temperature element of a P&T relief valve shall have a relieving capacity which is at least equal to the total input of the heaters when operating at their maximum capacity. Relief valves shall be rated according to ANSI Z21.22. Relief valves for systems where the maximum rate of heat input is less than 200,000 Btuh shall have 3/4 inch minimum inlets, and 3/4 inch outlets. Relief valves for systems where the maximum rate of heat input is greater than 200,000 Btuh shall have 1 inch minimum inlets, and 1 inch outlets. The discharge pipe from the relief valve shall be the size of the valve outlet.

2.4 FIXTURES

Fixtures shall be water conservation type, in accordance with NAPHCC-01. Fixtures for use by the physically handicapped shall be in accordance with ICC/ANSI A117.1. Vitreous china, nonabsorbent, hard-burned, and vitrified throughout the body shall be provided. Porcelain enameled ware shall have specially selected, clear white, acid-resisting enamel coating evenly applied on surfaces. No fixture will be accepted that shows cracks, crazes, blisters, thin spots, or other flaws. Fixtures shall be equipped with appurtenances such as traps, faucets, stop valves, and drain fittings. Each fixture and piece of equipment requiring connections to the drainage system, except grease interceptors, shall be equipped with a trap. Brass expansion or toggle bolts capped with acorn nuts shall be provided for supports, and polished chromium-plated pipe, valves, and fittings shall be provided where exposed to view. Fixtures with the supply discharge below the rim shall be equipped with backflow preventers. Internal parts of flush and/or flushometer valves, shower mixing valves, shower head face plates, pop-up stoppers of lavatory waste drains, and pop-up stoppers and overflow tees and shoes of bathtub waste drains may contain acetal resin, fluorocarbon, nylon, acrylonitrile-butadiene-styrene (ABS) or other plastic material, if the material has provided satisfactory service under actual commercial or industrial operating conditions for not less than 2 years. Plastic in contact with hot water shall be suitable for 180 degrees F water temperature. Plumbing fixtures shall be as indicated in paragraph PLUMBING FIXTURE SCHEDULE.

2.4.1 Lavatories

Vitreous china lavatories shall be provided with two integral molded lugs on the back-underside of the fixture and drilled for bolting to the wall in a manner similar to the hanger plate.

2.5 DRAINS

2.5.1 Floor Drains

Floor drains shall consist of a galvanized body, and adjustable perforated or slotted chromium-plated bronze, nickel-bronze, or nickel-brass strainer, consisting of grate and threaded collar. Floor drains shall be cast iron. Drains shall be of double drainage pattern for embedding in the floor construction. The strainer shall be adjustable to floor thickness. Drains shall be provided with threaded or caulked connection. In lieu of a caulked joint between the drain outlet and waste pipe, a neoprene rubber gasket conforming to ASTM C 564 may be installed, provided that the drain is specifically designed for the rubber gasket compression type joint. Floor and shower drains shall conform to ASME A112.21.1M.

2.6 TRAPS

Unless otherwise specified, traps shall be plastic per ASTM F 409 or copper-alloy adjustable tube type with slip joint inlet and swivel. Traps shall be without a clean-out. Tubes shall be copper alloy with walls not less than 0.032 inch thick within commercial tolerances, except on the outside of bends where the thickness may be reduced slightly in manufacture by usual commercial methods. Inlets shall have

rubber washer and copper alloy nuts for slip joints above the discharge level. Swivel joints shall be below the discharge level and shall be of metal-to-metal or metal-to-plastic type as required for the application. Nuts shall have flats for wrench grip. Outlets shall have internal pipe thread, except that when required for the application, the outlets shall have sockets for solder-joint connections. The depth of the water seal shall be not less than 2 inches. The interior diameter shall be not more than 1/8 inch over or under the nominal size, and interior surfaces shall be reasonably smooth throughout. A copper alloy "P" trap assembly consisting of an adjustable "P" trap and threaded trap wall nipple with cast brass wall flange shall be provided for lavatories. The assembly shall be a standard manufactured unit and may have a rubber-gasketed swivel joint.

2.7 WATER HEATER

Water heater types and capacities shall be as indicated. Each primary water heater shall have controls adjustable from 90 to 120 degrees F.

2.7.1 Electric Type

Electric type water heaters shall conform to UL 174 with dual heating elements. Each element shall be 3.0 kW. The elements shall be wired so that only one element can operate at a time.

2.8 HYPOCHLORINATOR

The system shall consist of a storage tank from which the hypochlorite solution shall, by means of a metering pump, be delivered through piping to the point of application. The system shall include gauges, back pressure regulator, strainer, pressure relief valve, sight glass and flow metering device, check valve, and hand valves. Construction shall be as simple as practicable to provide equipment isolation, bypass and reliable service and to be readily accessible for inspection, cleaning, adjustment, repairs, and replacements. System data and drawings shall be submitted for approval prior to delivery.

2.8.1 Capacity

Each chemical metering machine shall be capable of delivering chemical solution at any rate from the minimum flow rate to the maximum flow rate and shall be capable of continuous operation at rated capacity. Accuracy shall be plus or minus 2 percent over a 20 to 1 range from the required maximum capacity to the minimum pumping rate.

- a. Hydrochloric acid solution delivery.
 - Number of pumps: 1.
 - Controls: Manual rate adjustment.
 - Pressure: 110 psig backpressure at point of injection.
 - Feed/flow rate: Minimum .003 gph; maximum 0.21 gph.

2.8.2 Controls

The chemical metering machines shall be provided with the appurtenances and accessories, as required, for feed rate control. Manual range adjustment shall be provided on all systems.

2.8.2.1 Semiautomatic Control

Semiautomatic control shall have the capability to automatically start and stop the feeding machines in response to the operating or non-operating status of the receiving plant process. The pump start and stop shall respond to pump operation status.

2.8.2.2 Nonautomatic Control

Nonautomatic control shall have the capability for starting or stopping the feeding machines and adjustment of the solution feed rate by the operator.

2.8.3 Metering Pumps or Mechanical Devices

All metering pumps or mechanical devices shall be of the positive displacement, double diaphragm type, hydraulically activated and with diaphragms balanced during operation.

2.8.4 Drives for Metering Pumps

The metering pumps shall be supplied with and driven by alternating current electric motor drives.

Appropriate pressure regulation devices shall be provided.

2.8.4.1 Electric Motor Drive

Electric motor shall be of sufficient capacity to operate the feeding machines under all operating conditions without exceeding their rated nameplate current or power, or their specified temperature limits. The motors shall have starting characteristics and ruggedness necessary under the actual conditions of operations or clean-up procedures used in the areas where they will be located.

2.8.5 Solution Tanks

Solution tanks shall be manufactured of polyethylene, glass fiber reinforced polyester resin, ceramic, or rubber- or plastic-lined steel. Tank fittings shall be pressure rated for 1.5 times the weight of solution at full capacity. Each tank shall have the capacity listed and shall be equipped with a fill nozzle, vent, discharge, level instrument, drain, and two spare connections. Tanks shall be reinforced to withstand all forces when full of solution. Tanks shall be completely shop fabricated with no field assembly permitted. Drain connection shall provide complete drainage of the tank. All gaskets shall be fluorocarbon elastomer; nuts and bolts shall be Type 316 stainless steel; and steel supports shall be either stainless or epoxy coated. Each tank shall be furnished with a calibrated side wall strip to indicate volume. A permanent plastic sign indicating the tank contents shall be attached to the front of each tank. Tanks smaller than 900 mm (36 inches) (36 inches) in diameter shall be fitted with removable lids. Tanks larger than 900 mm (36 inches) (36 inches) in diameter shall be fitted with 600 mm (24-inch) (24-inch) man ways.

2.9 WATER STORAGE TANK

Tank shall be a steel, vertical, pressure-rated water tank with air precharge. Tank shall be provided with a factory-installed, butyl-rubber bladder. Tank shall be constructed with welded joints, and be ASME rated for a working pressure of 150 psig. Tank shall be provided with air-charging connections, pressure relief valve, and pressure gauge. The tank interior shall be provided with a finish that meets

the applicable requirements of AWWA or FDA and EPA regulatory standards for tasteless and odorless, potable-water tank linings.

2.10 HEAT TRACING

Potable water system shall be provided with electric heating cable to provide freeze protection for piping, valves, and tanks. Heating cable shall be a self-regulating type with a 3 watts/foot output. The heating cable construction shall include twin 16 AWG copper bus wires, a semiconductive polymer core matrix, and a thermoplastic rubber material jacket.

2.11 COMPRESSED AIR SYSTEM

2.11.1 Air Compressors

Air compressor unit shall be a factory-packaged assembly, including 3 phase, 460 volt motor controls, switches, wiring, accessories, and motor controllers, in a NEMA 250, Type 4 enclosure. Tank-mounted air compressors shall be manufactured to comply with UL listing requirements. Air compressors shall have manufacturer's name and address, together with trade name, and catalog number on a nameplate securely attached to the equipment. Each compressor shall start and stop automatically at upper and lower pressure limits of the system. Each compressor motor shall be provided with an across-the-line-type magnetic controller, complete with low-voltage release. An intake air filter and silencer shall be provided with each compressor. Aftercooler and moisture separator shall be installed between compressors and air receiver to remove moisture and oil condensates before the air enters the receiver. Aftercoolers shall be air-cooled. The air shall pass through a sufficient number of tubes to affect cooling. Tubes shall be sized to give maximum heat transfer. Cooling capacity of the aftercooler shall be sized for the total capacity of the compressors. Means shall be provided for draining condensed moisture from the receiver by an automatic float type trap. Capacities of air compressors and receivers shall be as indicated.

2.11.2 Lubricated Compressors

Compressors shall be one-stage, V-belt drive, capable of operating continuously against their designed discharge pressure, and shall operate at a speed not in excess of 1800 rpm. Compressors shall have the capacity and discharge pressure indicated. Compressors shall be assembled complete on a common subbase. The compressor main bearings shall be either roller or ball. The discharge passage of the high pressure air shall be piped to the air receiver with a copper pipe or tubing. A pressure gauge calibrated to 150 psi and equipped with a gauge cock and pulsation dampener shall be furnished for installation adjacent to pressure switches.

2.11.3 Air Receivers

Receivers shall be designed for 200 psi working pressure. Receivers shall be factory air tested to 1-1/2 times the working pressure. Receivers shall be equipped with safety relief valves and accessories, including pressure gauges and automatic and manual drains. The outside of air receivers may be galvanized or supplied with commercial enamel finish. Receivers shall be designed and constructed in accordance with ASME BPV VIII Div 1 and shall have the design working pressures specified herein. A display of the ASME seal on the receiver or a certified test report from an approved independent testing laboratory indicating conformance to the ASME Code shall be provided.

2.11.4 Intake Air Supply Filter

Dry type air filter shall be provided having a collection efficiency of 99 percent of particles larger than 10 microns. Filter body and media shall withstand a maximum 125 psi, capacity as indicated.

2.11.5 Pressure Regulators

The air system shall be provided with the necessary regulator valves to maintain the desired pressure for the installed equipment. Regulators shall be designed for a maximum inlet pressure of 125 psi and a maximum temperature of 200 degrees F. Regulators shall be single-seated, pilot-operated with valve plug, bronze body and trim or equal, and threaded connections. The regulator valve shall include a pressure gauge and shall be provided with an adjustment screw for adjusting the pressure differential from 0 to 125 psi. Regulator shall be sized as indicated.

PART 3 EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

Hubless cast-iron pipe shall not be installed under concrete floor slabs. Unprotected plastic pipe shall not be installed in air plenum. Installation of plastic pipe where in compliance with NFPA may be installed in accordance with PPFA-01. The plumbing system shall be installed complete with necessary fixtures, fittings, traps, valves, and accessories. Water and drainage piping shall be extended 5 feet outside the building, unless otherwise indicated. A gate valve and drain shall be installed on the water service line inside the building approximately 6 inches above the floor from point of entry. Piping shall be connected to the exterior service lines or capped or plugged if the exterior service is not in place. Sewer and water pipes shall be laid in separate trenches, except when otherwise shown. Exterior underground utilities shall be at least 12 inches below the average local frost depth or as indicated on the drawings. If trenches are closed or the pipes are otherwise covered before being connected to the service lines, the location of the end of each plumbing utility shall be marked with a stake or other acceptable means. Valves shall be installed with control no lower than the valve body.

3.1.1 Water Pipe, Fittings, and Connections

3.1.1.1 Utilities

The piping shall be extended to fixtures, outlets, and equipment. The hot-water and cold-water piping system shall be arranged and installed to permit draining. The supply line to each item of equipment or fixture, except faucets, flush valves, or other control valves which are supplied with integral stops, shall be equipped with a shutoff valve to enable isolation of the item for repair and maintenance without interfering with operation of other equipment or fixtures. Supply piping to fixtures, faucets, hydrants, shower heads, and flushing devices shall be anchored to prevent movement.

3.1.1.2 Cutting and Repairing

The work shall be carefully laid out in advance, and unnecessary cutting of construction shall be avoided. Damage to building, piping, wiring, or equipment as a result of cutting shall be repaired by mechanics skilled in the trade involved.

3.1.1.3 Protection of Fixtures, Materials, and Equipment

Pipe openings shall be closed with caps or plugs during installation. Fixtures and equipment shall be tightly covered and protected against dirt, water, chemicals, and mechanical injury. Upon completion of the work, the fixtures, materials, and equipment shall be thoroughly cleaned, adjusted, and operated. Safety guards shall be provided for exposed rotating equipment.

3.1.1.4 Mains, Branches, and Runouts

Piping shall be installed as indicated. Pipe shall be accurately cut and worked into place without springing or forcing. Structural portions of the building shall not be weakened. Aboveground piping shall run parallel with the lines of the building, unless otherwise indicated. Branch pipes from service lines may be taken from top, bottom, or side of main, using crossover fittings required by structural or installation conditions. Supply pipes, valves, and fittings shall be kept a sufficient distance from other work and other services to permit not less than 1/2 inch between finished covering on the different services. Bare and insulated water lines shall not bear directly against building structural elements so as to transmit sound to the structure or to prevent flexible movement of the lines. Water pipe shall not be buried in or under floors unless specifically indicated or approved. Changes in pipe sizes shall be made with reducing fittings. Use of bushings will not be permitted except for use in situations in which standard factory fabricated components are furnished to accommodate specific excepted installation practice. Change in direction shall be made with fittings, except that bending of pipe 4 inches and smaller will be permitted, provided a pipe bender is used and wide sweep bends are formed. The center-line radius of bends shall be not less than six diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations will not be acceptable.

3.1.1.5 Pipe Drains

Pipe drains indicated shall consist of 3/4 inch hose bibb with renewable seat and ball valve ahead of hose bibb. At other low points, 3/4 inch brass plugs or caps shall be provided. Disconnection of the supply piping at the fixture is an acceptable drain.

3.1.1.6 Expansion and Contraction of Piping

Allowance shall be made throughout for expansion and contraction of water pipe. Each hot-water and hot-water circulation riser shall have expansion loops or other provisions such as offsets, changes in direction, etc., where indicated and/or required. Risers shall be securely anchored as required or where indicated to force expansion to loops. Branch connections from risers shall be made with ample swing or offset to avoid undue strain on fittings or short pipe lengths. Horizontal runs of pipe over 50 feet in length shall be anchored to the wall or the supporting construction about midway on the run to force expansion, evenly divided, toward the ends. Sufficient flexibility shall be provided on branch runouts from mains and risers to provide for expansion and contraction of piping. Flexibility shall be provided by installing one or more turns in the line so that piping will spring enough to allow for expansion without straining. If mechanical grooved pipe coupling systems are provided, the deviation from design requirements for expansion and contraction may be allowed pending approval of Contracting Officer.

3.1.1.7 Commercial-Type Water Hammer Arresters

Commercial-type water hammer arresters shall be provided on hot- and cold-water supplies and shall be located as generally indicated, with precise location and sizing to be in accordance with PDI WH 201. Water hammer arresters, where concealed, shall be accessible by means of access doors or

removable panels. Commercial-type water hammer arresters shall conform to PDI WH 201. Vertical capped pipe columns will not be permitted.

3.1.2 Compressed Air Piping (Non-Oil Free)

Compressed air piping shall be galvanized steel pipe and installed as specified for water piping and suitable for 125 psig working pressure. Compressed air piping shall have supply lines and discharge terminals legibly and permanently marked at both ends with the name of the system and the direction of flow.

3.1.3 Joints

Installation of pipe and fittings shall be made in accordance with the manufacturer's recommendations. Mitering of joints for elbows and notching of straight runs of pipe for tees will not be permitted. Joints shall be made up with fittings of compatible material and made for the specific purpose intended.

3.1.3.1 Threaded

Threaded joints shall have American Standard taper pipe threads conforming to ASME B1.20.1. Only male pipe threads shall be coated with graphite or with an approved graphite compound, or with an inert filler and oil, or shall have a polytetrafluoroethylene tape applied.

3.1.3.2 Union and Flanged

Unions, flanges and mechanical couplings shall not be concealed in walls, ceilings, or partitions. Unions shall be used on pipe sizes 2-1/2 inches and smaller; flanges shall be used on pipe sizes 3 inches and larger.

3.1.3.3 Cast Iron Soil, Waste and Vent Pipe

Bell and spigot compression and hubless gasketed clamp joints for soil, waste and vent piping shall be installed per the manufacturer's recommendations.

3.1.3.4 Copper Tube and Pipe

The tube or fittings shall not be annealed when making connections. Connections shall be made with a multiflame torch.

- a. Brazed. Brazed joints shall be made in conformance with AWS B2.2, MSS SP-73, and CDA-02 with flux and are acceptable for line sizes. Copper to copper joints shall include the use of copper-phosphorus or copper-phosphorus-silver brazing metal without flux. Brazing of dissimilar metals (copper to bronze or brass) shall include the use of flux with either a copper-phosphorus, copper-phosphorus-silver or a silver brazing filler metal.
- b. Soldered. Soldered joints shall be made with flux and are only acceptable for lines 2 inches and smaller. Soldered joints shall conform to ASME B31.5 and CDA-02.
- c. Copper Tube Extracted Joint. An extracted mechanical joint may be made in copper tube. Joint shall be produced with an appropriate tool by drilling a pilot hole and drawing out the tube surface to form a collar having a minimum height of three times the thickness of the tube wall. To prevent the branch tube from being inserted beyond the depth of the

extracted joint, dimpled depth stops shall be provided. Branch tube shall be notched for proper penetration into fitting to ensure a free flow joint. Extracted joints shall be brazed in accordance with NAPHCC-01 using B-Cup series filler metal in accordance with MSS SP-73. Soldered extracted joints will not be permitted.

3.1.3.5 Plastic Pipe

PVC pipe shall have joints made with solvent cement elastomeric, threading, (threading of Schedule 80 Pipe is allowed only where required for disconnection and inspection; threading of Schedule 40 Pipe is not allowed), or mated flanged.

3.1.4 Dissimilar Pipe Materials

Connections between ferrous and non-ferrous copper pipe shall be made with dielectric unions or flange waterways. Connecting joints between plastic and metallic pipe shall be made with transition fitting for the specific purpose.

3.1.5 Corrosion Protection for Buried Pipe and Fittings

3.1.5.1 Cast Iron and Ductile Iron

Pressure pipe shall have protective coating, a cathodic protection system, and joint bonding. Pipe, fittings, and joints shall have a protective coating. The protective coating shall be completely encasing polyethylene tube or sheet in accordance with AWWA C105. Joints and fittings shall be cleaned, coated with primer, and wrapped with tape. The pipe shall be cleaned, coated, and wrapped prior to pipe tightness testing. Joints and fittings shall be cleaned, coated, and wrapped after pipe tightness testing. Tape shall conform to AWWA C203 and shall be applied with a 50 percent overlap. Primer shall be as recommended by the tape manufacturer.

3.1.5.2 Steel

Steel pipe, joints, and fittings shall be cleaned, coated with primer, and wrapped with tape. Pipe shall be cleaned, coated, and wrapped prior to pipe tightness testing. Joints and fittings shall be cleaned, coated, and wrapped after pipe tightness testing. Tape shall conform to AWWA C203 and shall be applied with a 50 percent overlap. Primer shall be as recommended by the tape manufacturer.

3.1.6 Pipe Sleeves and Flashing

Pipe sleeves shall be furnished and set in their proper and permanent location.

3.1.6.1 Sleeve Requirements

Pipes passing through concrete or masonry walls or concrete floors or roofs shall be provided with pipe sleeves fitted into place at the time of construction. Sleeves are not required for cast-iron soil pipe passing through concrete slab on grade, except where penetrating a membrane waterproof floor. A modular mechanical type sealing assembly may be installed in lieu of a waterproofing clamping flange and caulking and sealing of annular space between pipe and sleeve. The seals shall consist of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and sleeve with corrosion-protected carbon steel bolts, nuts, and pressure plates. The links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut. After the seal assembly is properly positioned in the sleeve, tightening of the

bolt shall cause the rubber sealing elements to expand and provide a watertight seal between the pipe and the sleeve. Each seal assembly shall be sized as recommended by the manufacturer to fit the pipe and sleeve involved. Sleeves shall not be installed in structural members, except where indicated or approved. Rectangular and square openings shall be as detailed. Each sleeve shall extend through its respective floor, or roof, and shall be cut flush with each surface, except for special circumstances. Pipe sleeves passing through floors in wet areas such as mechanical equipment rooms, lavatories, kitchens, and other plumbing fixture areas shall extend a minimum of 4 inches above the finished floor. Unless otherwise indicated, sleeves shall be of a size to provide a minimum of 1/4 inch clearance between bare pipe and inside of sleeve or between jacket over insulation and sleeves. Sleeves in bearing walls shall be steel pipe or cast-iron pipe. Sleeves for membrane waterproof floors shall be steel pipe, cast-iron pipe, or plastic pipe. Membrane clamping devices shall be provided on pipe sleeves for waterproof floors. Sleeves in nonbearing walls or ceilings may be steel pipe, cast-iron pipe, galvanized sheet metal with lock-type longitudinal seam, or moisture-resistant fiber or plastic. Plastic sleeves shall not be used in nonbearing fire walls, roofs, or floor/ceilings. Except as otherwise specified, the annular space between pipe and sleeve, or between jacket over insulation and sleeve, shall be sealed as indicated with sealants conforming to ASTM C 920 and with a primer, backstop material and surface preparation as specified in Section 07900 JOINT SEALING. Pipes passing through sleeves in concrete floors over crawl spaces shall be sealed as specified above. The annular space between pipe and sleeve or between jacket over insulation and sleeve shall not be sealed for interior walls which are not designated as fire rated. Sleeves through below-grade walls in contact with earth shall be recessed 1/2 inch from wall surfaces on both sides. Annular space between pipe and sleeve shall be filled with backing material and sealants in the joint between the pipe and concrete wall as specified above. Sealant selected for the earth side of the wall shall be compatible with dampproofing/waterproofing materials that are to be applied over the joint sealant.

3.1.6.2 Flashing Requirements

Pipes passing through roof or floor waterproofing membrane shall be installed through a 16 ounce copper flashing, each within an integral skirt or flange. Flashing shall be suitably formed, and the skirt or flange shall extend not less than 8 inches from the pipe and shall be set over the roof or floor membrane in a solid coating of bituminous cement. The flashing shall extend up the pipe a minimum of 10 inches. For cleanouts, the flashing shall be turned down into the hub and caulked after placing the ferrule. Pipes passing through pitched roofs shall be flashed, using lead or copper flashing, with an adjustable integral flange of adequate size to extend not less than 8 inches from the pipe in all directions and lapped into the roofing to provide a watertight seal. The annular space between the flashing and the bare pipe or between the flashing and the metal-jacket-covered insulation shall be sealed as indicated. Flashing for dry vents shall be turned down into the pipe to form a waterproof joint. Pipes, up to and including 10 inches in diameter, passing through roof or floor waterproofing membrane may be installed through a cast-iron sleeve with caulking recess, anchor lugs, flashing-clamp device, and pressure ring with brass bolts. Flashing shield shall be fitted into the sleeve clamping device. Pipes passing through wall waterproofing membrane shall be sleeved as described above. A waterproofing clamping flange shall be installed.

3.1.6.3 Waterproofing

Waterproofing at floor-mounted water closets shall be accomplished by forming a flashing guard from soft-tempered sheet copper. The center of the sheet shall be perforated and turned down approximately 1-1/2 inches to fit between the outside diameter of the drainpipe and the inside diameter of the cast-iron or steel pipe sleeve. The turned-down portion of the flashing guard shall be embedded in sealant to a depth of approximately 1-1/2 inches; then the sealant shall be finished off flush to floor level between the flashing guard and drainpipe. The flashing guard of sheet copper shall extend not less than 8 inches

from the drainpipe and shall be lapped between the floor membrane in a solid coating of bituminous cement. If cast-iron water closet floor flanges are used, the space between the pipe sleeve and drainpipe shall be sealed with sealant and the flashing guard shall be upturned approximately 1-1/2 inches to fit the outside diameter of the drainpipe and the inside diameter of the water closet floor flange. The upturned portion of the sheet fitted into the floor flange shall be sealed.

3.1.6.4 Optional Counterflashing

Instead of turning the flashing down into a dry vent pipe, or caulking and sealing the annular space between the pipe and flashing or metal-jacket-covered insulation and flashing, counterflashing may be accomplished by utilizing the following:

- a. A standard roof coupling for threaded pipe up to 6 inches in diameter.
- b. A tack-welded or banded-metal rain shield around the pipe.

3.1.6.5 Pipe Penetrations of Slab on Grade Floors

Where pipes, fixture drains, floor drains, cleanouts or similar items penetrate slab on grade floors, except at penetrations of floors with waterproofing membrane as specified in paragraphs Flashing Requirements and Waterproofing, a groove 1/4 to 1/2 inch wide by 1/4 to 3/8 inch deep shall be formed around the pipe, fitting or drain. The groove shall be filled with a sealant as specified in Section 07900 JOINT SEALING.

3.1.7 Supports

3.1.7.1 General

Hangers used to support piping 2 inches and larger shall be fabricated to permit adequate adjustment after erection while still supporting the load. Pipe guides and anchors shall be installed to keep pipes in accurate alignment, to direct the expansion movement, and to prevent buckling, swaying, and undue strain. Piping subjected to vertical movement when operating temperatures exceed ambient temperatures shall be supported by variable spring hangers and supports or by constant support hangers. In the support of multiple pipe runs on a common base member, a clip or clamp shall be used where each pipe crosses the base support member. Spacing of the base support members shall not exceed the hanger and support spacing required for an individual pipe in the multiple pipe run.

3.1.7.2 Pipe Supports and Structural Bracing, Seismic Requirements

Piping and attached valves shall be supported and braced to resist seismic loads. Structural steel required for reinforcement to properly support piping, headers, and equipment, but not shown, shall be provided. Material used for supports shall be as specified in Section 05120 STRUCTURAL STEEL.

3.1.7.3 Pipe Hangers, Inserts, and Supports

Installation of pipe hangers, inserts and supports shall conform to MSS SP-58 and MSS SP-69, except as modified herein.

- a. Types 5, 12, and 26 shall not be used.
- b. Type 3 shall not be used on insulated pipe.

- c. Type 18 inserts shall be secured to concrete forms before concrete is placed. Continuous inserts which allow more adjustment may be used if they otherwise meet the requirements for type 18 inserts.
- d. Type 19 and 23 C-clamps shall be torqued per MSS SP-69 and shall have both locknuts and retaining devices furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.
- e. Type 20 attachments used on angles and channels shall be furnished with an added malleable-iron heel plate or adapter.
- f. Type 24 may be used only on trapeze hanger systems or on fabricated frames.
- g. Type 39 saddles shall be used on insulated pipe 4 inches and larger when the temperature of the medium is 60 degrees F or higher. Type 39 saddles shall be welded to the pipe.
- h. Type 40 shields shall:
 - (1) Be used on insulated pipe less than 4 inches.
 - (2) Be used on insulated pipe 4 inches and larger when the temperature of the medium is 60 degrees F or less.
 - (3) Have a high density insert for pipe 2 inches and larger and for smaller pipe sizes when the insulation is suspected of being visibly compressed, or distorted at or near the shield/insulation interface. High density inserts shall have a density of 8 pcf or greater.
- i. Horizontal pipe supports shall be spaced as specified in MSS SP-69 and a support shall be installed not over 1 foot from the pipe fitting joint at each change in direction of the piping. Pipe supports shall be spaced not over 5 feet apart at valves. Operating temperatures in determining hanger spacing for PVC or CPVC pipe shall be 120 degrees F for PVC and 180 degrees F for CPVC. Horizontal pipe runs shall include allowances for expansion and contraction.
- j. Vertical pipe shall be supported at each floor, except at slab-on-grade, at intervals of not more than 15 feet nor more than 8 feet from end of risers, and at vent terminations. Vertical pipe risers shall include allowances for expansion and contraction.
- k. Type 40 shields used on insulated pipe shall have high density inserts with a density of 8 pcf or greater.
- l. Type 35 guides using steel, reinforced polytetrafluoroethylene (PTFE) or graphite slides shall be provided to allow longitudinal pipe movement. Slide materials shall be suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered. Lateral restraints shall be provided as needed. Where steel slides do not require provisions for lateral restraint the following may be used:
 - (1) On pipe 4 inches and larger when the temperature of the medium is 60 degrees F or higher, a Type 39 saddle, welded to the pipe, may freely rest on a steel plate.

- (2) On pipe less than 4 inches a Type 40 shield, attached to the pipe or insulation, may freely rest on a steel plate.
 - (3) On pipe 4 inches and larger carrying medium less than 60 degrees F a Type 40 shield, attached to the pipe or insulation, may freely rest on a steel plate.
- m. Pipe hangers on horizontal insulated pipe shall be the size of the outside diameter of the insulation. The insulation shall be continuous through the hanger on all pipe sizes and applications.
- n. Where there are high system temperatures and welding to piping is not desirable, the type 35 guide shall include a pipe cradle, welded to the guide structure and strapped securely to the pipe. The pipe shall be separated from the slide material by at least 4 inches or by an amount adequate for the insulation, whichever is greater.
- o. Hangers and supports for plastic pipe shall not compress, distort, cut or abrade the piping, and shall allow free movement of pipe except where otherwise required in the control of expansion/contraction.

3.1.8 Pipe Cleanouts

Pipe cleanouts shall be the same size as the pipe except that cleanout plugs larger than 4 inches will not be required. A cleanout installed in connection with cast-iron soil pipe shall consist of a long-sweep 1/4 bend or one or two 1/8 bends extended to the place shown. An extra-heavy cast-brass or cast-iron ferrule with countersunk cast-brass head screw plug shall be caulked into the hub of the fitting and shall be flush with the floor. Cleanouts in connection with other pipe, where indicated, shall be T-pattern, 90-degree branch drainage fittings with cast-brass screw plugs, except plastic plugs shall be installed in plastic pipe. Plugs shall be the same size as the pipe up to and including 4 inches. Cleanout tee branches with screw plug shall be installed at the foot of soil and waste stacks, at the foot of interior downspouts, on each connection to building storm drain where interior downspouts are indicated, and on each building drain outside the building. Cleanout tee branches may be omitted on stacks in single story buildings with slab-on-grade construction or where less than 18 inches of crawl space is provided under the floor. Cleanouts on pipe concealed in partitions shall be provided with chromium plated bronze, nickel bronze, nickel brass or stainless steel flush type access cover plates. Round access covers shall be provided and secured to plugs with securing screw. Square access covers may be provided with matching frames, anchoring lugs and cover screws. Cleanouts in finished walls shall have access covers and frames installed flush with the finished wall. Cleanouts installed in finished floors subject to foot traffic shall be provided with a chrome-plated cast brass, nickel brass, or nickel bronze cover secured to the plug or cover frame and set flush with the finished floor. Heads of fastening screws shall not project above the cover surface. Where cleanouts are provided with adjustable heads, the heads shall be cast iron.

3.2 WATER HEATERS

3.2.1 Relief Valves

No valves shall be installed between a relief valve and its water heater or storage tank. The P&T relief valve shall be installed where the valve actuator comes in contact with the hottest water in the heater. Whenever possible, the relief valve shall be installed directly in a tapping in the heater; otherwise, the P&T valve shall be installed in the hot-water outlet piping. A vacuum relief valve shall be provided on

the cold water supply line to the water heater and mounted above and within 6 inches above the top of the tank or water heater.

3.2.2 Heat Traps

Piping to and from each water heater shall be routed horizontally and downward a minimum of 2 feet before turning in an upward direction.

3.2.3 Connections to Water Heaters

Connections of metallic pipe to water heaters shall be made with dielectric unions or flanges.

3.3 HYPOCHLORINATOR

3.3.1 Chemical Feeding Equipment

The chemical metering machines and all equipment appurtenances shall provide a complete and integrated system in accordance with the instruction of the manufacturer and under the direct supervision of the manufacturer's representative.

3.3.2 Pump Support

Pump stands and platforms shall be adequate to support the pumping system.

3.4 FIXTURES AND FIXTURE TRIMMINGS

Angle stops, straight stops, stops integral with the faucets, or concealed type of lock-shield, and loose-key pattern stops for supplies with threaded, sweat or solvent weld inlets shall be furnished and installed with fixtures. Where connections between copper tubing and faucets are made by rubber compression fittings, a beading tool shall be used to mechanically deform the tubing above the compression fitting. Exposed traps and supply pipes for fixtures and equipment shall be connected to the rough piping systems at the wall, unless otherwise specified under the item. Floor and wall escutcheons shall be as specified. Drain lines and hot water lines of fixtures for handicapped personnel shall be insulated and do not require polished chrome finish. Plumbing fixtures and accessories shall be installed within the space shown.

3.4.1 Fixture Connections

Where space limitations prohibit standard fittings in conjunction with the cast-iron floor flange, special short-radius fittings shall be provided. Connections between earthenware fixtures and flanges on soil pipe shall be made gastight and watertight with a closet-setting compound or neoprene gasket and seal. Use of natural rubber gaskets or putty will not be permitted. Fixtures with outlet flanges shall be set the proper distance from floor or wall to make a first-class joint with the closet-setting compound or gasket and fixture used.

3.4.2 Flushometer Valves

Flushometer valves shall be secured to prevent movement by anchoring the long finished top spud connecting tube to wall adjacent to valve with approved metal bracket. Flushometer valves for water closets shall be installed 39 inches above the floor. Bumpers for water closet seats shall be installed on the flushometer stop.

3.4.3 Height of Fixture Rims Above Floor

Lavatories shall be mounted with rim 31 inches above finished floor.

3.4.4 Fixture Supports

Fixture supports for off-the-floor lavatories, urinals, water closets, and other fixtures of similar size, design, and use, shall be of the chair-carrier type. The carrier shall provide the necessary means of mounting the fixture, with a foot or feet to anchor the assembly to the floor slab. Adjustability shall be provided to locate the fixture at the desired height and in proper relation to the wall. Support plates, in lieu of chair carrier, shall be fastened to the wall structure only where it is not possible to anchor a floor-mounted chair carrier to the floor slab.

3.4.4.1 Support for Solid Masonry Construction

Chair carrier shall be anchored to the floor slab. Where a floor-anchored chair carrier cannot be used, a suitable wall plate shall be imbedded in the masonry wall.

3.4.4.2 Support for Cellular-Masonry Wall Construction

Chair carrier shall be anchored to floor slab. Where a floor-anchored chair carrier cannot be used, a suitable wall plate shall be fastened to the cellular wall using through bolts and a back-up plate.

3.4.4.3 Wall-Mounted Water Closet Gaskets

Where wall-mounted water closets are provided, reinforced wax, treated felt, or neoprene gaskets shall be provided. The type of gasket furnished shall be as recommended by the chair-carrier manufacturer.

3.4.5 Access Panels

Access panels shall be provided for concealed valves and controls, or any item requiring inspection or maintenance. Access panels shall be of sufficient size and located so that the concealed items may be serviced, maintained, or replaced. Access panels shall be as specified in Section 05500 MISCELLANEOUS METAL.

3.4.6 Sight Drains

Sight drains shall be installed so that the indirect waste will terminate 2 inches above the flood rim of the funnel to provide an acceptable air gap.

3.4.7 Traps

Each trap shall be placed as near the fixture as possible, and no fixture shall be double-trapped. Traps installed on cast-iron soil pipe shall be cast iron. Traps installed on steel pipe or copper tubing shall be recess-drainage pattern, or brass-tube type. Traps installed on plastic pipe may be plastic conforming to ASTM D 3311. Traps for acid-resisting waste shall be of the same material as the pipe.

3.5 VIBRATION-ABSORBING FEATURES

Mechanical equipment, including compressors and pumps, shall be isolated from the building structure by approved vibration-absorbing features, unless otherwise shown. Each foundation shall include an adequate number of standard isolation units. Each unit shall consist of machine and floor or foundation fastening, together with intermediate isolation material, and shall be a standard product with printed load rating. Piping connected to mechanical equipment shall be provided with flexible connectors. Isolation unit installation shall limit vibration to 10 percent of the lowest equipment rpm.

3.5.1 Tank- or Skid-Mounted Compressors

Floor attachment shall be as recommended by compressor manufacturer.

3.6 IDENTIFICATION SYSTEMS

3.6.1 Identification Tags

Identification tags made of brass, engraved laminated plastic, or engraved anodized aluminum, indicating service and valve number shall be installed on valves, except those valves installed on supplies at plumbing fixtures. Tags shall be 1-3/8 inch minimum diameter, and marking shall be stamped or engraved. Indentations shall be black, for reading clarity. Tags shall be attached to valves with No. 12 AWG, copper wire, chrome-plated beaded chain, or plastic straps designed for that purpose.

3.6.2 Color Coding

Color coding for piping identification shall be as specified in Section 09900 PAINTING, GENERAL.

3.7 ESCUTCHEONS

Escutcheons shall be provided at finished surfaces where bare or insulated piping, exposed to view, passes through floors, walls, or ceilings, except in boiler, utility, or equipment rooms. Escutcheons shall be fastened securely to pipe or pipe covering and shall be satin-finish, corrosion-resisting steel, polished chromium-plated zinc alloy, or polished chromium-plated copper alloy. Escutcheons shall be either one-piece or split-pattern, held in place by internal spring tension or setscrew.

3.8 PAINTING

Painting of pipes, hangers, supports, and other iron work, either in concealed spaces or exposed spaces, is specified in Section 09900 PAINTING, GENERAL.

3.9 TESTS FLUSHING AND STERILIZATION

3.9.1 Plumbing System

The plumbing system shall be tested in accordance with NAPHCC-01.

3.9.1.1 Compressed Air Piping (Nonoil-Free)

Piping systems shall be filled with oil-free dry air or gaseous nitrogen to 150 psig and hold this pressure for 2 hours with no drop in pressure.

3.9.2 Defective Work

If inspection or test shows defects, such defective work or material shall be replaced or repaired as necessary and inspection and tests shall be repeated. Repairs to piping shall be made with new materials. Caulking of screwed joints or holes will not be permitted.

3.9.3 System Flushing

After tests are completed, potable water piping shall be flushed. In general, sufficient water shall be used to produce a minimum water velocity of 2.5 feet per second through piping being flushed. Flushing shall be continued until discharge water shows no discoloration. System shall be drained at low points. Strainer screens shall be removed, cleaned, and replaced in line. After flushing and cleaning, systems shall be prepared for service by immediately filling water piping with clean, fresh potable water. Any stoppage, discoloration, or other damage to the finish, furnishings, or parts of the building due to the Contractor's failure to properly clean the piping system shall be repaired by the Contractor. When the work is complete, the hot-water system shall be adjusted for uniform circulation. Flushing devices and automatic control systems shall be adjusted for proper operation.

3.9.4 Operational Test

Upon completion of and prior to acceptance of the installation, the Contractor shall subject the plumbing system to operating tests to demonstrate satisfactory functional and operational efficiency. Such operating tests shall cover a period of not less than 8 hours for each system and shall include the following information in a report with conclusion as to the adequacy of the system:

- a. Time, date, and duration of test.
- b. Water pressures at the most remote and the highest fixtures.
- c. Operation of each fixture and fixture trim.
- d. Operation of each valve, hydrant, and faucet.
- e. Pump suction and discharge pressures.
- f. Temperature of each domestic hot-water supply.
- g. Operation of each floor and roof drain by flooding with water.
- h. Operation of each vacuum breaker.
- i. Complete operation of each water pressure booster system, including pump start pressure and stop pressure.
- j. Compressed air readings at each compressor and at each outlet. Each indicating instrument shall be read at 1/2 hour intervals. The report of the test shall be submitted in quadruplicate. The Contractor shall furnish instruments, equipment, and personnel required for the tests; the Government will furnish the necessary water and electricity.

3.9.5 Disinfection

After pressure tests have been made, the entire domestic hot- and cold-water distribution system shall be sterilized. System shall be thoroughly flushed with water of sufficient velocity until all entrained dirt and other foreign material have been removed, before introducing chlorinating material. The chlorinating material shall be hypochlorites or liquid chlorine. Water chlorination procedure shall be in accordance with AWWA M20. The chlorinating material shall be fed into the water piping system at a constant rate at a concentration of at least 50 parts per million (ppm). A properly adjusted hypochlorite solution injected into the main with a hypochlorinator, or liquid chlorine injected into the main through a solution-feed chlorinator and booster pump, shall be used. The chlorine residual shall be checked at intervals to ensure that the proper level is maintained. Chlorine application shall continue until the entire main is filled. The water shall remain in the system for a minimum of 24 hours. Each valve in the system being sterilized shall be opened and closed several times during the contact period to ensure its proper disinfection. Following the 24-hour period, no less than 25 ppm chlorine residual shall remain in the system. Water tanks shall be disinfected by the addition of chlorine directly to the filling water. Following a 6 hour period, no less than 50 ppm chlorine residual shall remain in the tank. The system including the tanks shall then be flushed with clean water until the residual chlorine is reduced to less than one part per million. During the flushing period each valve and faucet shall be opened and closed several times. From several points in the system the Contracting Officer will take samples of water in properly sterilized containers for bacterial examination. The samples of water shall be tested for total coliform organisms (coliform bacteria, fecal coliform, streptococcal, and other bacteria) in accordance with AWWA-01. The testing method used shall be either the multiple-tube fermentation technique or the membrane-filter technique. The sterilizing shall be repeated until tests indicate the absence of coliform organisms (zero mean coliform density per 100 milliliters) in the samples for at least 2 full days. The system will not be accepted until satisfactory bacteriological results have been obtained.

3.10 PLUMBING FIXTURE SCHEDULE

P-1 WATER CLOSET:

Siphon-jet, elongated bowl, top supply spud, ASME A112.19.2M, wall mounted.

Seat - CID A-A-238, Type A, white plastic, elongated, open front.

Flushometer Valve - ASSE 1037, large diaphragm type with non-hold-open feature, backcheck angle control stop, and vacuum breaker. Minimum upper chamber inside diameter of not less than 2-5/8 inches at the point where the diaphragm is sealed between the upper and lower chambers. The maximum water use shall be 1.6 gallons per flush.

P-2 URINAL:

Wall hanging, with integral trap and extended shields, ASME A112.19.2M siphon jet. Top supply connection, back outlet.

Flushometer Valve - Similar to Flushometer Valve for P-1. The maximum water use shall be 1 gallon per flush.

P-3 LAVATORY:

Manufacturer's standard sink depth, vitreous china ASME A112.19.2M, straight back.

Faucet - Faucets shall be center set type. Faucets shall have metal replaceable cartridge control unit or metal cartridge units with diaphragm which can be replaced without special tools. Valves and handles shall be copper alloy. Connection between valve and spout for center-set faucet shall be of rigid metal tubing. The flow shall be limited to 2.5 gpm at a flowing pressure of 80 psi.

Handles - Lever type. Cast, formed, or drop forged copper alloy.

Drain - Strainer shall be copper alloy or stainless steel. Pop-up drain shall include stopper, lift rods, jam nut, washer, and tail piece. See paragraph FIXTURES for optional plastic accessories.

P-4 KITCHEN SINK:

Ledge back with holes for faucet and spout double bowl 32 x 21 inches enameled cast iron ASME A112.19.1M.

Faucet and Spout - Cast or wrought copper alloy. Aerator shall have internal threads. The flow shall be limited to 2.5 gpm at a flowing water pressure of 80 psi.

Handle - Cast copper alloy, wrought copper alloy, or stainless steel. Single lever type.

Drain Assembly - Plug, cup strainer, crossbars, jam nuts, washers, couplings, stopper, etc. shall be copper alloy or stainless steel.

3.11 POSTED INSTRUCTIONS

Framed instructions under glass or in laminated plastic, including wiring and control diagrams showing the complete layout of the entire system, shall be posted where directed. Condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system shall be prepared in typed form, framed as specified above for the wiring and control diagrams and posted beside the diagrams. The framed instructions shall be posted before acceptance testing of the systems.

3.12 PERFORMANCE OF WATER HEATING EQUIPMENT

Standard rating condition terms are as follows:

EF = Energy factor, overall efficiency.

ET = Thermal efficiency with 70 degrees F delta T.

EC = Combustion efficiency, 100 percent - flue loss when smoke = 0 (trace is permitted).

SL = Standby loss in W/sq. ft. based on 80 degrees F delta T, or in percent per hour based on nominal 90 degrees F delta T.

HL = Heat loss of tank surface area.

V = Storage volume in liters

3.12.1 Storage Water Heaters

3.12.1.1 Electric

- a. Storage capacity of 120 gallons or less, and input rating of 12 kW or less: minimum energy factor (EF) shall be 0.95-0.00132V per 10 CFR 430.
- b. Storage capacity of more than 120 gallons or input rating more than 12 kW: maximum SL shall be 1.9 W/sq. ft. per ASHRAE 90.1, Addenda B.

End of Section

DIVISION 15 - MECHANICAL

SECTION 15895

AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM

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SECTION 15895

AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AIR CONDITIONING AND REFRIGERATION INSTITUTE (ARI)

ARI 410 (1996) Forced-Circulation Air-Cooling and Air-Heating Coils

ARI Guideline D (1987) Application and Installation of Central Station Air-Handling Units

AIR MOVEMENT AND CONTROL ASSOCIATION (AMCA)

AMCA 210 (1985) Laboratory Methods of Testing Fans for Rating

AMCA 300 (1996) Reverberant Room Method for Sound Testing of Fans

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABEMA)

ABEMA 9 (1990) Load Ratings and Fatigue Life for Ball Bearings

ABEMA 11 (1990) Load Ratings and Fatigue Life for Roller Bearings

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 53 (1993a) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless

ASTM A 123 (1989a) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

ASTM A 924 (1994) General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process

ASTM B 117 (1994) Operating Salt Spray (Fog) Testing Apparatus

ASTM D 520 (1984; R 1989) Zinc Dust Pigment

ASTM D 1654 (1992) Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments

ASTM D 3359 (1995) Measuring Adhesion by Tape Test

ASTM E 437 (1992) Industrial Wire Cloth and Screens (Square Opening Series)

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 52.1 (1992) Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter

ASHRAE 70 (1991) Method of Testing Rating the Performance of Air Outlets and Inlets

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58 (1993) Pipe Hangers and Supports - Materials, Design and Manufacture

MSS SP-69 (1991) Pipe Hangers and Supports - Selection and Application

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1 (1993; Rev 1; Rev 2) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 90A (1996) Installation of Air Conditioning and Ventilating Systems

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA-06 (1995) HVAC Duct Construction Standards - Metal and Flexible

SMACNA-10 (1985) HVAC Air Duct Leakage Test Manual

UNDERWRITERS LABORATORIES (UL)

UL-01 (1996; Supple) Building Materials Directory

UL 181 (1996; Rev Oct 1996) Factory-Made Air Ducts and Air Connectors

UL 214 (1997) Tests for Flame-Propagation of Fabrics and Films

UL 586 (1996) High-Efficiency, Particulate, Air Filter Units

UL 900 (1994) Test Performance of Air Filter Units

1.2 COORDINATION OF TRADES

Ductwork, piping offsets, fittings, and accessories shall be furnished as required to provide a complete installation and to eliminate interference with other construction.

1.3 DELIVERY AND STORAGE

Equipment delivered and placed in storage shall be stored with protection from the weather, humidity and temperature variations, dirt and dust, or other contaminants.

1.4 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Components and Equipment Data; GA.

Manufacturer's catalog data shall be included with the detail drawings for the following items. The data shall be highlighted to show model, size, options, etc., that are intended for consideration. Data shall be adequate to demonstrate compliance with contract requirements for the following:

- a. Piping Components
- b. Ductwork Components
- c. Air Systems Equipment
- d. Air Handling Units
- e. Energy Recovery Devices
- f. Terminal Units

SD-04 Drawings

Air Supply, Distribution, Ventilation, and Exhaust Equipment; GA.

Drawings shall consist of equipment layout including assembly and installation details and electrical connection diagrams; ductwork layout showing the location of all supports and hangers, typical hanger details, gauge reinforcement, reinforcement spacing rigidity classification, and static pressure and seal classifications; and piping layout showing the location of all guides and anchors, the load imposed on each support or anchor, and typical support details. Drawings shall include any information required to demonstrate that the system has been coordinated and will properly function as a unit and shall show equipment relationship to other parts of the work, including clearances required for operation and maintenance.

SD-06 Instructions

Test Procedures; FIO.

Proposed test procedures for piping hydrostatic test, ductwork leak test, and performance tests of systems, at least 2 weeks prior to the start of related testing.

Welding Procedures; GA.

A copy of qualified welding procedures, at least 2 weeks prior to the start of welding operations.

System Diagrams; GA.

Proposed diagrams, at least 2 weeks prior to start of related testing. System diagrams that show the layout of equipment, piping, and ductwork, and typed condensed operation manuals explaining preventative maintenance procedures, methods of checking the system for normal, safe operation, and procedures for safely starting and stopping the system shall be framed under glass or laminated plastic. After approval, these items shall be posted where directed.

SD-07 Schedules

Test Schedules; FIO.

Proposed test schedules for hydrostatic test of piping, ductwork leak test, and performance tests, at least 2 weeks prior to the start of related testing.

Field Training Schedule; FIO.

Proposed schedule for field training, at least 2 weeks prior to the start of related training.

SD-08 Statements

Similar Services; FIO.

Statement demonstrating successful completion of similar services on at least 5 projects of similar size and scope, at least 2 weeks prior to submittal of other items required by this section.

Welding Qualification; GA.

A list of names and identification symbols of qualified welders and welding operators, at least 2 weeks prior to the start of welding operations.

SD-09 Reports

Test Reports; GA.

Test reports for the piping hydrostatic test, ductwork leak test, and performance tests in booklet form, upon completion of testing. Reports shall document phases of tests performed including initial test summary, repairs/adjustments made, and final test results.

SD-13 Certificates

Bolts; FIO.

Written certification from the bolt manufacturer that the bolts furnished comply with the requirements of this specification. The certification shall include illustrations of product markings, and the number of each type of bolt to be furnished.

SD-19 Operation and Maintenance Manuals

Air Supply, Distribution, Ventilation, and Exhaust Manuals; GA.

Six (6) manuals listing step-by-step procedures required for system startup, operation, shutdown, and routine maintenance, at least 2 weeks prior to field training. The manuals shall include the manufacturer's name, model number, parts list, list of parts and tools that should be kept in stock by the owner for routine maintenance including the name of a local supplier, simplified wiring and controls diagrams, troubleshooting guide, and recommended service organization (including address and telephone number) for each item of equipment. Each service organization submitted shall be capable of providing four (4) hour onsite response to a service call on an emergency basis.

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

Components and equipment shall be standard products of a manufacturer regularly engaged in the manufacturing of products that are of a similar material, design and workmanship. The standard products shall have been in satisfactory commercial or industrial use for 2 years before bid opening. The 2-year experience shall include applications of components and equipment under similar circumstances and of similar size. The 2 years must be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures. Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown. The equipment items shall be supported by a service organization.

2.2 ASBESTOS PROHIBITION

Asbestos and asbestos-containing products shall not be used.

2.3 NAMEPLATES

Equipment shall have a nameplate that identifies the manufacturer's name, address, type or style, model or serial number, and catalog number.

2.4 EQUIPMENT GUARDS AND ACCESS

Belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts exposed to personnel contact shall be fully enclosed or guarded according to OSHA requirements. High temperature equipment and piping exposed to contact by personnel or where it creates a potential fire hazard shall be properly guarded or covered with insulation of a type specified.

2.5 ELECTRICAL WORK

Electrical motor-driven equipment specified shall be provided complete with motor, motor starter, and controls. Unless otherwise specified, electric equipment, including wiring and motor efficiencies, shall be according to Section 16415 ELECTRICAL WORK, INTERIOR. Electrical characteristics and enclosure type shall be as shown. Unless otherwise indicated, motors of 1 hp and above shall be high efficiency type. Motor starters shall be provided complete with thermal overload protection and other appurtenances necessary. Each motor shall be according to NEMA MG 1 and shall be of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the

motor. Manual or automatic control and protective or signal devices required for the operation specified, and any control wiring required for controls and devices, but not shown, shall be provided. Where two-speed or variable-speed motors are indicated, solid-state variable-speed controller may be provided to accomplish the same function. Solid-state variable-speed controllers shall be utilized for motors rated 10 hp or less. Adjustable frequency drives shall be used for larger motors.

2.6 CONTROLS

Controls shall consist of a low voltage thermostat located in office.

2.7 DUCTWORK COMPONENTS

2.7.1 Metal Ductwork

All aspects of metal ductwork construction, including all fittings and components, shall comply with SMACNA-06 unless otherwise specified. Elbows shall be radius type with a centerline radius of 1-1/2 times the width or diameter of the duct where space permits. Otherwise, elbows having a minimum radius equal to the width or diameter of the duct or square elbows with factory fabricated turning vanes may be used. Static pressure Class 1/2, 1, and 2 inch w.g. ductwork shall meet the requirements of Seal Class C. Class 3 through 10 inch shall meet the requirements of Seal Class A. Sealants shall conform to fire hazard classification specified in Section 15250 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Pressure sensitive tape shall not be used as a sealant. Spiral lock seam duct, and flat oval shall be made with duct sealant and locked with not less than 3 equally spaced drive screws or other approved methods indicated in SMACNA-06. The sealant shall be applied to the exposed male part of the fitting collar so that the sealer will be on the inside of the joint and fully protected by the metal of the duct fitting. One brush coat of the sealant shall be applied over the outside of the joint to at least 2 inch band width covering all screw heads and joint gap. Dents in the male portion of the slip fitting collar will not be acceptable. Outdoor air intake ducts and plenums shall be fabricated with watertight soldered or brazed joints and seams.

2.7.1.1 Transitions

Diverging air flow transitions shall be made with each side pitched out a maximum of 15 degrees, for an included angle of 30 degrees. Transitions for converging air flow shall be made with each side pitched in a maximum of 30 degrees, for an included angle of 60 degrees, or shall be as indicated. Factory-fabricated reducing fittings for systems using round duct sections when formed to the shape of the ASME short flow nozzle, need not comply with the maximum angles specified.

2.7.1.2 Metallic Flexible Duct

Metallic type duct shall be single-ply galvanized steel. Duct shall be of corrugated/interlocked, folded and knurled type seam construction, bendable without damage through 180 degrees with a throat radius equal to 1/2 duct diameter. Duct shall conform to UL 181 and shall be rated for positive or negative working pressure of 15 inches water gauge at 350 degrees F when duct is aluminum, and 650 degrees F when duct is galvanized steel or stainless steel.

2.7.1.3 Insulated Nonmetallic Flexible Duct Runouts

Flexible duct runouts shall be used only where indicated. Runout length shall be as shown on the drawings, but shall in no case exceed 10 feet. Runouts shall be preinsulated, factory fabricated, and shall comply with NFPA 90A and UL 181. Either field or factory applied vapor barrier shall be provided. Where coil induction or high velocity units are supplied with vertical air inlets, a streamlined and vaned and mitered elbow transition piece shall be provided for connection to the flexible duct or

hose. The last elbow to these units, other than the vertical air inlet type, shall be a die-stamped elbow and not a flexible connector. Insulated flexible connectors may be used as runouts. The insulated material and vapor barrier shall conform to the requirements of Section 15250 THERMAL INSULATION FOR MECHANICAL SYSTEMS. The insulation material surface shall not be exposed to the air stream.

2.7.1.4 General Service Duct Connectors

A flexible duct connector approximately 6 inches in width shall be provided where sheet metal connections are made to fans or where ducts of dissimilar metals are connected. For round/oval ducts, the flexible material shall be secured by stainless steel or zinc-coated, iron clinch-type draw bands. For rectangular ducts, the flexible material locked to metal collars shall be installed using normal duct construction methods. The composite connector system shall comply with UL 214 and be classified as "flame-retarded fabrics" in UL-01.

2.7.1.5 High Temperature Service Duct Connections

Material shall be approximately 3/32 inch thick, 35 to 40-ounce per square yard weight, plain weave fibrous glass cloth with, nickel/chrome wire reinforcement for service in excess of 1200 degrees F.

2.7.2 Ductwork Accessories

2.7.2.1 Splitters and Manual Balancing Dampers

Splitters and manual balancing dampers shall be furnished with accessible operating mechanisms. Where operators occur in finished portions of the building, operators shall be chromium plated with all exposed edges rounded. Splitters shall be operated by quadrant operators or 3/16 inch rod brought through the side of the duct with locking setscrew and bushing. Two rods are required on splitters over 8 inches. Manual volume control dampers shall be operated by locking-type quadrant operators. Dampers and splitters shall be 2 gauges heavier than the duct in which installed. Unless otherwise indicated, multi-leaf dampers shall be opposed blade type with maximum blade width of 12 inches. Access doors or panels shall be provided for all concealed damper operators and locking setscrews. Unless otherwise indicated, the locking-type quadrant operators for dampers, when installed on ducts to be thermally insulated, shall be provided with stand-off mounting brackets, bases, or adapters to provide clearance between the duct surface and the operator not less than the thickness of the insulation. Stand-off mounting items shall be integral with the operator or standard accessory of the damper manufacturer. Volume dampers shall be provided where indicated.

2.7.2.2 Air Deflectors and Branch Connections

Air deflectors shall be provided at duct mounted supply outlets, at takeoff or extension collars to supply outlets, at duct branch takeoff connections, and at 90 degree elbows, as well as at locations as indicated on the drawings or otherwise specified. Conical branch connections or 45 degree entry connections may be used in lieu of deflectors or extractors for branch connections. All air deflectors, except those installed in 90 degree elbows, shall be provided with an approved means of adjustment. Adjustment shall be made from easily accessible means inside the duct or from an adjustment with sturdy lock on the face of the duct. When installed on ducts to be thermally insulated, external adjustments shall be provided with stand-off mounting brackets, integral with the adjustment device, to provide clearance between the duct surface and the adjustment device not less than the thickness of the thermal insulation. Air deflectors shall be factory-fabricated units consisting of curved turning vanes or louver blades designed to provide uniform air distribution and change of direction with minimum turbulence or pressure loss. Air deflectors shall be factory or field assembled. Blade air deflectors, also called blade air extractors, shall be approved factory fabricated units consisting of equalizing grid

and adjustable blade and lock. Adjustment shall be easily made from the face of the diffuser or by position adjustment and lock external to the duct. Stand-off brackets shall be provided on insulated ducts and are described herein. Fixed air deflectors, also called turning vanes, shall be provided in 90 degree elbows.

2.7.3 Duct Sleeves, Framed Prepared Openings, Closure Collars

2.7.3.1 Duct Sleeves

Duct sleeves shall be provided for round ducts 15 inches in diameter or less passing through floors, walls, ceilings, or roof, and installed during construction of the floor, wall, ceiling, or roof. Round ducts larger than 15 inches in diameter and square, rectangular, and oval ducts passing through floors, walls, ceilings, or roof shall be installed through framed prepared openings. The Contractor shall be responsible for the proper size and location of sleeves and prepared openings. Sleeves and framed openings are also required where grilles, registers, and diffusers are installed at the openings. Framed prepared openings shall be fabricated from 20 gauge galvanized steel, unless otherwise indicated. Where sleeves are installed in bearing walls or partitions, black steel pipe, ASTM A 53, Schedule 20 shall be used. Sleeve shall provide 1 inch clearance between the duct and the sleeve or 1 inch clearance between the insulation and the sleeve for insulated ducts.

2.7.3.2 Framed Prepared Openings

Openings shall have 1 inch clearance between the duct and the opening or 1 inch clearance between the insulation and the opening for insulated ducts.

2.7.3.3 Closure Collars

Collars shall be fabricated of galvanized sheet metal not less than 4 inches wide, unless otherwise indicated, and shall be installed on exposed ducts on each side of walls or floors where sleeves or prepared openings are provided. Collars shall be installed tight against surfaces. Collars shall fit snugly around the duct or insulation. Sharp edges of the collar around insulated duct shall be ground smooth to preclude tearing or puncturing the insulation covering or vapor barrier. Collars for round ducts 15 inches in diameter or less shall be fabricated from 20 gauge galvanized steel. Collars for round ducts larger than 15 inches and square, and rectangular ducts shall be fabricated from 18 gauge galvanized steel. Collars shall be installed with fasteners on maximum 6 inch centers, except that not less than 4 fasteners shall be used.

2.7.4 Diffusers, Registers, and Grilles

Units shall be factory-fabricated of steel, corrosion-resistant steel, or aluminum and shall distribute the specified quantity of air evenly over space intended without causing noticeable drafts, air movement faster than 50 fpm in occupied zone, or dead spots anywhere in the conditioned area. Outlets for diffusion, spread, throw, and noise level shall be as required for specified performance. Performance shall be certified according to ASHRAE 70. Inlets and outlets shall be sound rated and certified according to ASHRAE 70. Sound power level shall be as indicated. Diffusers and registers shall be provided with volume damper with accessible operator, unless otherwise indicated; or if standard with the manufacturer, an automatically controlled device will be acceptable. Volume dampers shall be opposed blade type for all diffusers and registers, except linear slot diffusers. Linear slot diffusers shall be provided with round or elliptical balancing dampers. Where the inlet and outlet openings are located less than 7 feet above the floor, they shall be protected by a grille or screen according to NFPA 90A.

2.7.4.1 Diffusers

Diffuser types shall be as indicated. Ceiling mounted units shall be furnished with anti-smudge devices, unless the diffuser unit minimizes ceiling smudging through design features. Diffusers shall be provided with air deflectors of the type indicated. Ceiling mounted units shall be installed with rims tight against ceiling. Sponge rubber gaskets shall be provided between ceiling and surface mounted diffusers for air leakage control. Suitable trim shall be provided for flush mounted diffusers. Duct collar connecting the duct to diffuser shall be airtight and shall not interfere with volume controller. Return or exhaust units shall be similar to supply diffusers.

2.7.4.2 Registers and Grilles

Units shall be four-way directional-control type, except that return and exhaust registers may be fixed horizontal or vertical louver type similar in appearance to the supply register face. Registers shall be provided with sponge-rubber gasket between flanges and wall or ceiling. Wall supply registers shall be installed at least 6 inches below the ceiling unless otherwise indicated. Return and exhaust registers shall be located 6 inches above the floor unless otherwise indicated. Four-way directional control may be achieved by a grille face which can be rotated in 4 positions or by adjustment of horizontal and vertical vanes. Grilles shall be as specified for registers, without volume control damper.

2.7.5 Louvers

2.7.5.1 General

Except as otherwise indicated, provide manufacturer's standard motor operated louvers where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation.

2.7.5.2 Performance

Provide louvers that have minimum free area, and maximum pressure drop for each type as listed in manufacturer's current data, complying with louver schedule.

2.7.5.3 Substrate Compatibility

Provide louvers with frame and sill styles that are compatible with adjacent substrate, and that are specifically manufactured to fit into construction openings with accurate fit and adequate support, for weatherproof specifications installation. Refer to general construction drawings and specifications for types of substrate which will contain each type of louver. Where louvers are to be installed in existing block and brick walls, provide a minimum 1/8" steel frame around block/ brick cutout.

2.7.5.4 Materials

Construct of aluminum extrusions, ASTM B 221, Alloy 6063-T52. Weld units or use stainless steel fasteners.

2.7.5.5 Louver Screens

On inside face of exterior louvers, provide 1/2" square mesh anodized aluminum wire bird screens mounted in removable extruded aluminum frames.

2.7.6 Air Vents, Penthouses, and Goosenecks

Air vents, penthouses, and goosenecks shall be fabricated from galvanized steel sheets with galvanized structural shapes. Sheet metal thickness, reinforcement, and fabrication shall conform to SMACNA-06. Louver blades shall be accurately fitted and secured to frames. Edges of louver blades shall be folded or beaded for rigidity and baffled to exclude driving rain. Air vents, penthouses, and goosenecks shall be provided with bird screen.

2.7.7 Bird Screens and Frames

Bird screens shall conform to ASTM E 437, Type I, Class 1, 2 by 2 mesh, 0.063 inch diameter aluminum wire or 0.031 inch diameter stainless steel wire. Frames shall be removable type or stainless steel or extruded aluminum.

2.7.8 Dampers

Manual dampers will be installed in all branch lines and in accordance with the drawings.

2.8 AIR SYSTEMS EQUIPMENT

2.8.1 Fans

Fans shall be tested and rated according to AMCA 210. Fans may be connected to the motors either directly or indirectly with V-belt drive. V-belt drives shall be designed for not less than 120 percent of the connected driving capacity. Motor sheaves shall be variable pitch for 15 hp and below and fixed pitch as defined by ARI Guideline D. Variable pitch sheaves shall be selected to drive the fan at a speed which will produce the specified capacity when set at the approximate midpoint of the sheave adjustment. When fixed pitch sheaves are furnished, a replaceable sheave shall be provided when needed to achieve system air balance. Motors for V-belt drives shall be provided with adjustable rails or bases. Removable metal guards shall be provided for all exposed V-belt drives, and speed-test openings shall be provided at the center of all rotating shafts. Fans shall be provided with personnel screens or guards on both suction and supply ends, except that the screens need not be provided, unless otherwise indicated, where ducts are connected to the fan. Fan and motor assemblies shall be provided with vibration-isolation supports or mountings as indicated. Vibration-isolation units shall be standard products with published loading ratings. Each fan shall be selected to produce the capacity required at the fan static pressure indicated. Sound power level shall be as indicated. The sound power level values shall be obtained according to AMCA 300. Standard AMCA arrangement, rotation, and discharge shall be as indicated.

2.8.1.1 Axial Flow Fans

Axial flow fans shall be complete with drive components and belt guard, and shall have a steel housing, cast fan wheel, cast or welded steel diffusers, fan shaft, bearings, and mounting frame as a factory-assembled unit. Fan wheels shall have radially projecting blades of airfoil cross section and shall be dynamically balanced and keyed to the fan shaft. Fan bearings and drive shafts shall be enclosed and isolated from the air stream. Fan bearings shall be sealed against dust and dirt, shall be permanently lubricated or with accessible grease fittings, and shall be precision self-aligning ball or roller type. Bearing life shall be L50 rated at not less than 200,000 hours of operation as defined by ABEMA 9 and ABEMA 11. Fan inlets shall be provided with an aerodynamically shaped bell and an inlet cone. Diffuser or straightening vanes shall be provided at the fan discharge to minimize turbulence and provide smooth discharge air flow. Fan unit shall be provided with inlet and outlet flanges, inlet screen. Unless otherwise indicated, motors shall not exceed 1800 rpm and shall have

open enclosure. Motor starters shall be magnetic across-the-line with general-purpose enclosure. Remote manual switch with pilot indicating light shall be provided where indicated.

2.8.1.2 Ceiling Exhaust Fans

Suspended cabinet-type ceiling exhaust fans shall be centrifugal type, direct-driven. Fans shall have acoustically insulated housing. Integral backdraft damper shall be chatter-proof. The integral face grille shall be of egg-crate design or louver design. Fan motors shall be mounted on vibration isolators. Unit shall be provided with mounting flange for hanging unit from above. Fans shall be UL listed.

2.8.2 Coils

Coils shall be fin-and-tube type constructed of seamless copper red brass tubes and aluminum or copper fins mechanically bonded or soldered to the tubes. Copper tube wall thickness shall be a minimum of 0.016 inches. Aluminum fins shall be 0.0055 - 0.0075 inch minimum thickness. Copper fins shall be 0.0045 inch minimum thickness. Casing and tube support sheets shall be not lighter than 16 gauge galvanized steel, formed to provide structural strength. When required, multiple tube supports shall be provided to prevent tube sag. Each coil shall be tested at the factory under water at not less than 400 psi air pressure and shall be suitable for 200 psi working pressure. Coils shall be mounted for counterflow service. Coils shall be rated and certified according to ARI 410.

2.8.2.1 Direct-Expansion Coils

Direct-expansion coils shall be suitable for the refrigerant involved. Suction headers shall be seamless copper tubing or seamless or resistance welded steel tube with copper connections. Supply headers shall consist of a distributor which shall distribute the refrigerant through seamless copper tubing equally to all circuits in the coil. Tubes shall be circuited to ensure minimum pressure drop and maximum heat transfer. Circuiting shall permit refrigerant flow from inlet to suction outlet without causing oil slugging or restricting refrigerant flow in coil. Each coil to be field installed shall be completely dehydrated and sealed at the factory upon completion of pressure tests.

2.8.3 Air Filters

Air filters shall be listed according to requirements of UL 900, except high efficiency particulate air filters of 99.97 percent efficiency by the DOP Test method shall be as listed under the Label Service and shall meet the requirements of UL 586.

2.8.3.1 Extended Surface Pleated Panel Filters

Filters shall be 2 inch depth, sectional, disposable type of the size indicated and shall have an average efficiency of 25 to 30 percent when tested according to ASHRAE 52.1. Initial resistance at 500 feet per minute shall not exceed 0.36 inches water gauge. Filters shall be UL Class 2. Media shall be nonwoven cotton and synthetic fiber mat. A wire support grid bonded to the media shall be attached to a moisture resistant fiberboard frame. All four edges of the filter media shall be bonded to the inside of the frame to prevent air bypass and increase rigidity.

2.9 HEAT PUMPS

2.9.1 General

Provide package heat pump units of capacities required and having accessories as scheduled; designed and tested for use with Refrigerant 22 and equipped with fittings which permit mechanical or sweat connection.

2.9.1.1 Casings

Provide casing materials of sufficient gage with internal bracing to be self-supporting. Clean, condition, and prime paint sheet metal parts prior to final assembly. Apply final coat(s) of enamel to surfaces after assembly.

2.9.1.2 Fans

Provide factory-assembled and tested fan units of centrifugal type, directly driven. The fan will discharge through adjustable louvers for 2, 3, or 4- way discharge.

2.9.1.3 Coils

Provide copper tube coils, mechanically bonded to aluminum plate fins, with all joints brazed, rated at 250 psig and leak tested at 350 psig minimum air pressure. Enclose in a factory fabricated casing with piping connections extended beyond casing, and a condensate pan with condensate pump. Coil shall have a factory installed refrigerant metering device.

2.9.1.4 Accessories

Provide an indoor thermostat, an indoor coil defrost thermostat and cleanable filter.

2.9.1.5 Compressors

Provide a semi-hermetic compressor(s) with crankcase heater, automatically reversible oil pump, internal and external motor protection.

2.9.1.6 Fans

Condensing fans shall be propeller type, direct driven by a factory-lubricated motor, and situated for vertical discharge.

2.9.1.7 Controls

Controls and protective devices shall include:

- a. High and low pressure stats
- b. Section line accumulator and pressure relief
- c. Short cycle protection or safety lock-out protection
- d. Defrost control
- e. 24-volt transformer for external control circuit

2.10 FACTORY PAINTING

Units which are not of galvanized construction according to ASTM A 123 or ASTM A 924 shall be factory painted with a corrosion resisting paint finish. Internal and external ferrous metal surfaces shall be cleaned, phosphatised and coated with a paint finish which has been tested according to ASTM B 117, ASTM D 1654, and ASTM D 3359. Evidence of satisfactory paint performance for a minimum of 125 hours for units to be installed indoors and 500 hours for units to be installed outdoors shall be submitted. Rating of failure at the scribe mark shall be not less than 6, average creepage not greater than 1/8 inch. Rating of the inscribed area shall not be less than 10, no failure. On units constructed of galvanized steel which have been welded, exterior surfaces of welds or welds that have burned through

from the interior shall receive a final shop docket of zinc-rich protective paint according to ASTM D 520 Type I.

2.11 ELECTRICAL INFRARED HEATERS

2.11.1 General

Provide electric infrared heater units of capacities required and having accessories as scheduled.

2.11.1.1 Reflector Housing

Housing shall be 0.040 gold anodized aluminum.

2.11.1.2 Reflector Insert

Insert shall be 0.032 BOS aluminum.

2.11.1.3 Reflector Extrusion

Extrusion shall be extra heavy duty aluminum with front edge grooved to hold reflector insert.

2.11.1.4 Heating Element

Element shall be U-shaped unbreakable Incoloy metal sheath with a nickel chromium heating coil imbedded in magnesium oxide powder.

2.11.1.5 Wiring

Units shall be factory wired for 3-phase operation with a high temperature silicone wire.

PART 3 EXECUTION

3.1 INSTALLATION

Work shall be installed as shown and according to the manufacturer's diagrams and recommendations.

3.1.1 Supports

3.1.1.1 General

Hangers used to support piping 2 inches and larger shall be fabricated to permit adequate adjustment after erection while still supporting the load. Pipe guides and anchors shall be installed to keep pipes in accurate alignment, to direct the expansion movement, and to prevent buckling, swaying, and undue strain. Piping subjected to vertical movement when operating temperatures exceed ambient temperatures shall be supported by variable spring hangers and supports or by constant support hangers.

3.1.1.2 Seismic Requirements (Pipe Supports and Structural Bracing)

Piping and attached valves shall be supported and braced to resist seismic loads. Structural steel required for reinforcement to properly support piping, headers, and equipment but not shown shall be provided under this section.

3.1.1.3 Pipe Hangers, Inserts and Supports

Pipe hangers, inserts, and supports shall conform to MSS SP-58 and MSS SP-69, except as modified herein. Types 5, 12, and 26 shall not be used.

- a. Hangers: Type 3 shall not be used on insulated piping.
- b. Inserts: Type 18 inserts shall be secured to concrete forms before concrete is placed. Continuous inserts which allow more adjustment may be used if they otherwise meet the requirements for Type 18 inserts.
- c. C-Clamps: Type 19 and 23 C-clamps shall be torqued per MSS SP-69 and have both locknuts and retaining devices, furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.
- d. Angle Attachments: Type 20 attachments used on angles and channels shall be furnished with an added malleable-iron heel plate or adapter.
- e. Hangers: Type 24 may be used only on trapeze hanger systems or on fabricated frames.
- f. Horizontal Pipe Supports: Horizontal pipe supports shall be spaced as specified in MSS SP-69 and a support shall be installed not over 1 foot from the pipe fitting joint at each change in direction of the piping. Pipe supports shall be spaced not over 5 feet apart at valves. Pipe hanger loads suspended from steel joist with hanger loads between panel points in excess of 50 pounds shall have the excess hanger loads suspended from panel points.
- f. Vertical Pipe Supports: Vertical pipe shall be supported at each floor, except at slab-on-grade, and at intervals of not more than 15 feet, not more than 8 feet from end of risers, and at vent terminations.
- h. Pipe Guides: Type 35 guides using steel reinforced polytetrafluoroethylene (PTFE) or graphite slides shall be provided where required to allow longitudinal pipe movement. Lateral restraints shall be provided as required. Slide materials shall be suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered.
- i. Steel Slides: Where steel slides do not require provisions for restraint of lateral movement, an alternate guide method may be used. On piping 4 inches and larger with medium 60 degrees F or greater, a Type 39 saddle may be welded to the pipe and freely rest on a steel plate. On piping under 4 inches, a Type 40 protection shield may be attached to the pipe or insulation and freely rest on a steel slide plate.
- j. High Temperature Guides with Cradles: Where there are high system temperatures and welding to piping is not desirable, the Type 35 guide shall include a pipe cradle, welded to the guide structure and strapped securely to the pipe. The pipe shall be separated from the slide material by at least 4 inches, or by an amount adequate for the insulation, whichever is greater.
- k. Insulated Pipe: Insulation on horizontal pipe shall be continuous through hangers for hot and cold piping. Other requirements on insulated pipe are specified in Section 15250 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

3.1.2 Anchors

Anchors shall be provided wherever necessary or indicated to localize expansion or to prevent undue strain on piping. Anchors shall consist of heavy steel collars with lugs and bolts for clamping and attaching anchor braces, unless otherwise indicated. Anchor braces shall be installed in the most effective manner to secure the desired results using turnbuckles where required. Supports, anchors, or stays shall not be attached where they will injure the structure or adjacent construction during installation or by the weight of expansion of the pipeline.

3.1.3 Pipe Sleeves

Sleeves shall not be installed in structural members except where indicated or approved. Rectangular and square openings shall be as detailed. Each sleeve shall extend through its respective wall, floor, or roof, and shall be cut flush with each surface. Pipes passing through concrete or masonry wall or concrete floors or roofs shall be provided with pipe sleeves fitted into place at the time of construction. Unless otherwise indicated, sleeves shall provide a minimum of 1/4 inch all-around clearance between bare pipe and sleeves or between jacket over insulation and sleeves. Sleeves in bearing walls, waterproofing membrane floors, and wet areas shall be steel pipe or cast iron pipe. Sleeves in non-bearing walls, floors, or ceilings may be steel pipe, cast iron pipe, galvanized sheet metal with lock-type longitudinal seam and of the metal thickness indicated, or moisture resistant fiber or plastic. Except in pipe chases or interior walls, the annular space between pipe and sleeve or between jacket over insulation and sleeve, in non-fire rated walls, shall be sealed as indicated and specified in Section 07900 JOINT SEALING. Pipes passing through wall waterproofing membrane shall be sleeved as specified above, and a waterproofing clamping flange shall be installed as indicated.

3.1.3.1 Roof and Floor Sleeves

Pipes passing through roof or floor waterproofing membrane shall be installed through a 17-ounce copper sleeve or a 0.032 inch thick aluminum sleeve, each within an integral skirt or flange. Flashing sleeve shall be suitably formed, and skirt or flange shall extend not less than 8 inches from the pipe and shall be set over the roof or floor membrane in a troweled coating of bituminous cement. Unless otherwise shown, the flashing sleeve shall extend up the pipe a minimum of 2 inches above highest floor level or a minimum of 10 inches above the roof. The annular space between the flashing sleeve and the bare pipe or between the flashing sleeve and the metal-jacket-covered insulation shall be sealed as indicated. Pipes up to and including 10 inches in diameter passing through roof or floor waterproofing membrane may be installed through a cast iron sleeve with caulking recess, anchor lugs, flashing clamp device, and pressure ring with brass bolts. Waterproofing membrane shall be clamped into place and sealant shall be placed in the caulking recess. In lieu of a waterproofing clamping flange and caulking and sealing of annular space between pipe and sleeve or conduit and sleeve, a modular mechanical type sealing assembly may be installed. Seals shall consist of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe/conduit and sleeve with corrosion protected carbon steel bolts, nuts, and pressure plates. Links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut. After the seal assembly is properly positioned in the sleeve, tightening of the bolt shall cause the rubber sealing elements to expand and provide a watertight seal between the pipe/conduit and the sleeve. Each seal assembly shall be sized as recommended by the manufacturer to fit the pipe/conduit and sleeve involved.

3.1.3.2 Escutcheons

Escutcheons shall be provided at finished surfaces where exposed piping, bare or insulated, passes through floors, walls, or ceilings except in boiler, utility, or equipment rooms. Where sleeves project

slightly from floors, special deep-type escutcheons shall be used. Escutcheons shall be secured to pipe or pipe covering.

3.1.4 Condensate Drain Lines

Water seals shall be provided in the condensate drain from all units. The depth of each seal shall be 2 inches plus the number of inches, measured in water gauge, of the total static pressure rating of the unit to which the drain is connected. Water seals shall be constructed of 2 tees and an appropriate U-bend with the open end of each tee plugged. Pipe cap or plug cleanouts shall be provided where indicated. Air conditioner drain lines shall be insulated as specified in Section 15250 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

3.1.5 Pipe-Alignment Guides

Pipe-alignment guides shall be provided where indicated for expansion loops, offsets, and bends and as recommended by the manufacturer for expansion joints, not to exceed 5 feet on each side of each expansion joint, and in lines 4 inches or smaller not more than 2 feet on each side of the joint.

3.1.6 Access Panels

Access panels shall be provided for concealed valves, vents, controls, dampers, and items requiring inspection or maintenance. Access panels shall be of sufficient size and located so that the concealed items may be serviced and maintained or completely removed and replaced. Access panels shall be as specified in Section 05500 MISCELLANEOUS METAL.

3.1.7 Flexible Connectors

Pre-insulated flexible connectors and flexible duct shall be attached to other components in accordance with the latest printed instructions of the manufacturer to ensure a vapor tight joint. Hangers, when required to suspend the connectors, shall be of the type recommended by the connector or duct manufacturer and shall be provided at the intervals recommended.

3.1.8 Sleeved and Framed Openings

For non-fire rated penetrations, the space shall be packed as specified in Section 07900 JOINT SEALING.

3.1.9 Metal Ductwork

Installation shall be according to SMACNA-06 unless otherwise indicated. Duct supports for sheet metal ductwork shall be according to SMACNA-06, unless otherwise specified. Friction beam clamps indicated in SMACNA-06 shall not be used. Risers on high velocity ducts shall be anchored in the center of the vertical run to allow ends of riser to move due to thermal expansion. Supports on the risers shall allow free vertical movement of the duct. Supports shall be attached only to structural framing members and concrete slabs. Supports shall not be anchored to metal decking unless a means is provided and approved for preventing the anchor from puncturing the metal decking. Where supports are required between structural framing members, suitable intermediate metal framing shall be provided. Where C-clamps are used, retainer clips shall be provided.

3.1.9.1 Exposed Ductwork

Exposed ductwork shall be fabricated from minimum 18 gauge, Type 304L or 316L, stainless steel with continuously welded joints and seams. Ducts shall be pitched to drain at hoods and low points indicated. Surface finish shall match hoods.

3.1.10 Dust Control

To prevent the accumulation of dust, debris and foreign material during construction, temporary dust control protection shall be provided. The distribution system (supply and return) shall be protected with temporary seal-offs at all inlets and outlets at the end of each day's work. Temporary protection shall remain in place until system is ready for startup.

3.1.11 Insulation

Thickness and application of insulation materials for ductwork, piping, and equipment shall be according to Section 15250 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Outdoor air intake ducts and plenums shall be externally insulated up to the point where the outdoor air reaches the conditioning unit.

3.1.12 Duct Test Holes

Holes with closures or threaded holes with plugs shall be provided in ducts and plenums as indicated or where necessary for the use of pitot tube in balancing the air system. Extensions, complete with cap or plug, shall be provided where the ducts are insulated.

3.1.13 Power Transmission Components Adjustment

V-belts and sheaves shall be tested for proper alignment and tension prior to operation and after 72 hours of operation at final speed. Belts on drive side shall be uniformly loaded, not bouncing. Alignment of direct driven couplings shall be to within 50 percent of manufacturer's maximum allowable range of misalignment.

3.2 FIELD PAINTING AND PIPING IDENTIFICATION

Finish painting of items only primed at the factory or surfaces not specifically noted otherwise and identification for piping are specified in Section 09900 PAINTING, GENERAL.

3.3 DUCTWORK LEAK TEST

Ductwork leak test shall be performed for the entire air distribution and exhaust system, including fans, coils, filters, etc. Test procedure, apparatus, and report shall conform to SMACNA-10. The maximum allowable leakage rate is 60 cfm. Ductwork leak test shall be completed with satisfactory results prior to applying insulation to ductwork exterior.

3.4 CLEANING AND ADJUSTING

Inside of ducts, plenums, and casing shall be thoroughly cleaned of debris and blown free of small particles of rubbish and dust and then shall be vacuum cleaned before installing outlet faces. Equipment shall be wiped clean, with traces of oil, dust, dirt, or paint spots removed. Temporary filters shall be provided prior to startup of all fans that are operated during construction, and new filters shall be installed after all construction dirt has been removed from the building, and the ducts, plenums, casings, and other items specified have been vacuum cleaned. System shall be maintained in this clean

condition until final acceptance. Bearings shall be properly lubricated with oil or grease as recommended by the manufacturer. Belts shall be tightened to proper tension. Control valves and other miscellaneous equipment requiring adjustment shall be adjusted to setting indicated or directed. Fans shall be adjusted to the speed indicated by the manufacturer to meet specified conditions.

3.5 TESTING, ADJUSTING, AND BALANCING

System shall be tested and balanced in accordance with the requirements shown on drawings and as indicated herein. Testing, adjusting, and balancing shall begin only when the air supply and distribution, including controls, has been completed, with the exception of performance tests.

3.6 PERFORMANCE TESTS

After testing, adjusting, and balancing has been completed as specified, each system shall be tested as a whole to see that all items perform as integral parts of the system and temperatures and conditions are evenly controlled throughout the building. Corrections and adjustments shall be made as necessary to produce the conditions indicated or specified. Capacity tests and general operating tests shall be conducted by an experienced engineer. Tests shall cover a period of not less than 3 days for each system and shall demonstrate that the entire system is functioning according to the specifications. Coincidental chart recordings shall be made at points indicated on the drawings for the duration of the time period and shall record the temperature at space thermostats or space sensors, the humidity at space humidistats or space sensors and the ambient temperature and humidity in a shaded and weather protected area.

3.7 FIELD TRAINING

The Contractor shall conduct a training course for operating and maintenance personnel as designated by the Contracting Officer. Training shall be provided for a period of 4 hours of normal working time and shall start after the system is functionally complete but prior to the performance tests. The field instruction shall cover all of the items contained in the approved Operating and Maintenance Instructions.

End of Section

DIVISION 16 - ELECTRICAL

SECTION 16375

ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND

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SECTION 16375

ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C80.1	(1995) Rigid Steel Conduit - Zinc Coated
ANSI C119.1	(1997) Sealed Insulated Underground Connector Systems Rated 600 Volts

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 123	(1997a) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 153	(1995) Zinc Coating (Hot-Dip) on Iron and Steel Hardware

ASSOCIATION OF EDISON ILLUMINATING COMPANIES (AEIC)

AEIC CS6	(1996; Rev Mar 1989) Ethylene Propylene Rubber Insulated Shielded Power Cables Rated 5 Through 69 kV
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INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(1997) National Electrical Safety Code
IEEE Std 48	(1996) Standard Test Procedures and Requirements for Alternating-Current Cable Terminations 2.5 kV through 765 kV
IEEE Std 81	(1983) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.(Part I)

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA FB 1	(1993) Fittings, Cast Metal Boxes and Conduit Bodies for Conduit and Cable Assemblies
NEMA WC 8	(1993) Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(1999) National Electrical Code
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UNDERWRITERS LABORATORIES (UL)

UL 6	(1997) Rigid Metal Conduit
UL 486A	(1997) Wire Connectors and Soldering Lugs for Use with Copper Conductors
UL 486B	(1997) Wire Connectors for Use with Aluminum Conductors
UL 514A	(1996) Metallic Outlet Boxes

1.2 SERVICE CONDITIONS

Items provided under this section shall be specifically suitable for the following service conditions:

- a. Fungus Control - Not Required.
- b. Altitude 300 feet
- c. Ambient Temperature 104 degrees F
- d. Frequency 60 Hz.
- e. Ventilation
- f. Seismic Zone - This facility is a Seismic Hazard Exposure Group "I" Seismic Zone 3 with $A_v = 0.25$.
- g. Humidity Control - Space heat in specified enclosures and motors.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Manufacturer's Catalog Data; GA.

Catalog cuts, brochures, circulars, specifications, product data, and printed information in sufficient detail and scope to verify compliance with the requirements of the contract documents.

SD-04 Drawings

As-Built Drawings; GA.

The as-built drawings shall be a record of the construction as installed. The drawings shall include the information shown on the contract drawings as well as deviations, modifications, and changes from the contract drawings, however minor. The as-built drawings shall be a full sized set of prints marked to reflect deviations, modifications, and changes. The as-built drawings shall be complete and show the location, size, dimensions, part identification, and other information. Upon completion of the work, the Contractor shall provide three full sized sets of the marked prints.

SD-09 Reports

Cable Installation Reports; GA.

Six copies of the information described below in 8-1/2 by 11 inch binders having a minimum of 3 rings from which material may readily be removed and replaced, including a separate section for each cable pull. Sections shall be separated by heavy plastic dividers with tabs, with all data sheets signed and dated by the person supervising the pull.

- a. Site layout drawing with all cable pulls numerically identified.
- b. A list of equipment used, with calibration certifications. The manufacturer of and quantity of lubricant used on pull.
- c. The cable manufacturer and type of cable.
- d. The dates of cable pulls, time of day, and ambient temperature.
- e. The length of cable pull and calculated cable pulling tensions.
- f. The actual cable pulling tensions encountered during pull.

SD-13 Certificates

Materials and Equipment; GA.

Where materials or equipment are specified to conform to the standards of the Underwriters Laboratories (UL) or to be constructed or tested, or both, in accordance with the standards of the American National Standards Institute (ANSI), the Institute of Electrical and Electronics Engineers (IEEE), or the National Electrical Manufacturers Association (NEMA), the Contractor shall submit proof that the items provided conform to such requirements. The label of, or listing by, UL will be acceptable as evidence that the items conform. Either a certification or a published catalog specification data statement, to the effect that the item is in accordance with the referenced ANSI or IEEE standard, will be acceptable as evidence that the item conforms. A similar certification or

published catalog specification data statement to the effect that the item is in accordance with the referenced NEMA standard, by a company listed as a member company of NEMA, will be acceptable as evidence that the item conforms. In lieu of such certification or published data, the Contractor may submit a certificate from a recognized testing agency equipped and competent to perform such services, stating that the items have been tested and that they conform to the requirements listed, including methods of testing of the specified agencies. Compliance with above-named requirements does not relieve the Contractor from compliance with any other requirements of the specifications.

Cable Installer Qualifications; GA.

The Contractor shall provide at least one on-site person in a supervisory position with a documentable level of competency and experience to supervise cable pulling operations.

1.4 DELIVERY, STORAGE, AND HANDLING

Stored items shall be protected from the environment in accordance with the manufacturer's published instructions.

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

Material and equipment shall be the standard product of a manufacturer regularly engaged in the manufacture of the product and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Items of the same classification shall be identical including equipment, assemblies, parts, and components.

2.2 CORROSION PROTECTION

2.2.1 Aluminum Materials

Aluminum shall not be used.

2.2.2 Ferrous Metal Hardware

Ferrous metal hardware shall be hot-dip galvanized in accordance with ASTM A 153 and ASTM A 123.

2.2.3 Finishing

Painting required for surfaces not otherwise specified and finish painting of items only primed at the factory shall be as specified in Section 09900 PAINTING, GENERAL.

2.3 CABLES

Cables shall be single conductor type unless otherwise indicated.

2.3.1 Medium-Voltage Cables

2.3.1.1 General

Medium voltage cables shall conform to the requirements NEMA WC 8 and AEIC CS6 for cables utilizing ethylene-propylene-rubber (EPR) insulation. Cables shall be in accordance with the requirements of NFPA 70. Conductor shall be stranded, Class B annealed copper, covered with an extruded semi-conducting EPR strand screen, 115 mil ethylene propylene rubber insulation, extruded EPR semi-conducting insulation screen, 5 mil bare copper shielding tape with 12 1/2% overlap, 80 mil PVC jacket 5KV Type MV-105, 133% insulation level.

2.3.1.2 Insulation

Cables shall utilize ethylene-propylene-rubber (EPR) insulation. Cables shall be provided with 133 percent insulation level. The EP insulation must contain no polyethylene polymer as a component. The ethylene content of any of the EP rubbers used in the insulation must not exceed 72% by weight ethylene.

2.3.1.3 Jackets

Cables shall be provided with a nonmetallic jacket.

2.3.1.4 Neutrals

Neutral conductors of grounded neutral systems except for concentric neutral cables shall be of the same insulation material as phase conductors, except that a 600-volt insulation rating is acceptable.

2.3.1.5 Shielding

Cables rated for above 2 kV shall have both conductor and insulation shielding for each phase. Conductor strand screen, insulation and insulation screen shall be extruded simultaneously (triple tandem extrusion). The extruded shield shall be clean stripping and shall have a peel strength from the insulation between 7 and 18 lbs./0.5" width.

Medium-voltage cables shall be rated for a circuit voltage of 5 kV as indicated.

2.3.2 Low-Voltage Cables

Cables shall be rated 600 volts and shall conform to the requirements of NFPA 70. Cables shall utilize ethylene-propylene-rubber (EPR) insulation and shall conform to the requirements of NEMA WC 8.

2.3.2.1 In Duct

Cables shall be single-conductor cable, Type RHW, THW, THWN, USE, or XHHW in accordance with NFPA 70.

2.4 CABLE JOINTS, TERMINATIONS, AND CONNECTORS

2.4.1 Low-Voltage Cable Splices

Low-voltage cable splices and terminations shall be rated at not less than 600 Volts. Splices in conductors No. 10 AWG and smaller shall be made with an insulated, solderless, pressure type connector, conforming to the applicable requirements of UL 486A. Splices in conductors No. 8 AWG and larger shall be made with noninsulated, solderless, pressure type connector, conforming to the applicable requirements of UL 486A and UL 486B. Splices shall then be covered with an insulation and jacket material equivalent to the conductor insulation and jacket. Splices below grade or in wet locations shall be sealed type conforming to ANSI C119.1 or shall be waterproofed by a sealant-filled, thick wall, heat shrinkable, thermosetting tubing or by pouring a thermosetting resin into a mold that surrounds the joined conductors.

2.4.2 Terminations

Terminations shall be in accordance with IEEE Std 48, Class 1 or Class 2; of the molded elastomer, wet-process porcelain, prestretched elastomer, heat-shrinkable elastomer, or taped type. Acceptable elastomers are track-resistant silicone rubber or track-resistant ethylene propylene compounds, such as ethylene propylene rubber or ethylene propylene diene monomer. Terminations shall be of the outdoor type, except that where installed inside outdoor equipment housings which are sealed against normal infiltration of moisture and outside air, indoor, Class 2 terminations are acceptable. Class 3 terminations are not acceptable. Terminations, where required, shall be provided with mounting brackets suitable for the intended installation and with grounding provisions for the cable shielding, metallic sheath, and armor.

2.4.2.1 Factory Preformed Type

Molded elastomer, wet-process porcelain, prestretched, and heat-shrinkable terminations shall utilize factory preformed components to the maximum extent practicable rather than tape build-up. Terminations shall have basic impulse levels as required for the system voltage level. Leakage distances shall comply with wet withstand voltage test requirements of IEEE Std 48 for the next higher Basic Insulation Level (BIL) level. Anti-tracking tape shall be applied over exposed insulation of preformed molded elastomer terminations.

2.5 CONDUIT AND DUCTS

Ducts shall be single, round-bore type, with wall thickness and fittings suitable for the application. Duct lines shall be nonencased direct-burial, thick-wall type.

2.5.1 Metallic Conduit

Rigid galvanized steel conduit shall comply with UL 6 and ANSI C80.1. Metallic conduit fittings and outlets shall comply with UL 514A and NEMA FB 1.

2.5.2 Conduit Sealing Compound

Compounds for sealing ducts and conduit shall have a putty-like consistency workable with the hands at temperatures as low as 35 degrees F, shall neither slump at a temperature of 300 degrees F, nor harden materially when exposed to the air. Compounds shall adhere to clean surfaces of fiber or plastic ducts; metallic conduits or conduit coatings; concrete, masonry, or lead; any cable sheaths, jackets,

covers, or insulation materials; and the common metals. Compounds shall form a seal without dissolving, noticeably changing characteristics, or removing any of the ingredients. Compounds shall have no injurious effect upon the hands of workmen or upon materials.

PART 3 EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

Equipment and devices shall be installed and energized in accordance with the manufacturer's published instructions.

3.1.1 Conformance to Codes

The installation shall comply with the requirements and recommendations of NFPA 70 and IEEE C2 as applicable.

3.1.2 Verification of Dimensions

The Contractor shall become familiar with details of the work, shall verify dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing any work. The Contractor is specifically advised to coordinate the size of the connection boxes on the stormwater pump motors to assure adequate space to permit stress cone terminations.

3.2 CABLE INSTALLATION

The manufacturer's installation manual shall govern cable construction, insulation type, cable diameter, bending radius, cable temperature, lubricants, coefficient of friction, conduit cleaning, storage procedures, moisture seals, testing for and purging moisture.

3.2.1 Cable Installation Plan and Procedure

Cable shall be installed in accordance with the cable manufacturer's recommendations. Each conductor shall be identified by means of a colored tape band at each termination point.

3.2.1.1 Cable Inspection

The cable reel shall be inspected for correct storage positions, signs of physical damage, and broken end seals. If end seal is broken, moisture shall be removed from cable in accordance with the cable manufacturer's recommendations.

3.2.1.2 Conduit/Duct Cleaning

Conduit/duct shall be cleaned with an assembly consisting of 2 wire brushes, a rag and a flexible mandrel which is 1/4 inch less than inside diameter of duct and is furnished in lengths recommended by the manufacturer for the specific size and type of duct. The cleaning assembly shall be pulled through conduit a minimum of two times or until less than a volume of 8 cubic inch of debris is expelled from the duct.

3.2.1.3 Duct Lubrication

The cable lubricant shall be compatible with the cable jacket for cable that is being installed. Application of lubricant shall be in accordance with lubricant manufacturer's recommendations.

3.2.1.4 Cable Installation

The Contractor shall provide a cable feeding truck and a cable pulling winch as required. The Contractor shall provide a pulling grip or pulling eye in accordance with cable manufacturer's recommendations. The pulling grip or pulling eye apparatus shall be attached to polypropylene or manilla rope followed by lubricant front end packs and then by power cables. A dynamometer shall be used to monitor pulling tension. Pulling tension shall not exceed cable manufacturer's recommendations. The Contractor shall not allow cables to cross over while cables are being fed into duct. For cable installation in cold weather, cables shall be kept at 50 degrees F temperature for at least 24 hours before installation.

3.2.1.5 Cable Installation Plan

The Contractor shall submit a cable installation plan for all cable pulls for power feeders size 4/0 AWG and larger in accordance with the detail drawings portion of paragraph SUBMITTALS. Cable installation plan shall include:

- a. Cable pulls identified in numeric order of expected pulling sequence and direction of cable pull.
- b. List of cable installation equipment.
- c. Lubricant manufacturer's application instructions.
- d. Procedure for resealing cable ends to prevent moisture from entering cable.
- e. Cable pulling tension calculations of all cable pulls.
- f. Cable percentage conduit fill.
- g. Cable sidewall thrust pressure.
- h. Cable minimum bend radius and minimum diameter of pulling wheels used.
- i. Cable jam ratio.
- j. Maximum allowable pulling tension on each different type and size of conductor.
- k. Maximum allowable pulling tension on pulling device.

3.2.2 Duct Line

Cables shall be installed in duct lines where indicated. Cable splices in medium voltage and low-voltage cables shall not be permitted. Neutral and grounding conductors shall be installed in the same duct with their associated phase conductors.

3.2.2.1 Trenching

Trenches for duct lines shall be excavated to depths required to provide the minimum necessary cable cover. Bottoms of trenches shall be smooth and free of stones and sharp objects. Where bottoms of trenches comprise materials other than sand, a 3 inch layer of sand shall be laid first and compacted to approximate densities of surrounding firm soil.

3.2.2.2 Other Requirements

Where duct lines cross under roads or levees or other paving exceeding 5 feet in width, such cables shall be installed in concrete-encased ducts. Ducts shall extend at least 1 foot beyond each edge of any paving.

3.3 CABLE TERMINATIONS

Medium-voltage cable terminations shall be made by qualified cable installers. Qualifications of cable installers shall be submitted in accordance with paragraph SUBMITTALS. Shields shall be applied as required to continue the shielding system through each entire cable joint. Shields may be integrally molded parts of preformed joints. Shields shall be grounded at each joint or in accordance with manufacturer's recommended practice. Cable terminations shall provide insulation and jacket equivalent to that of the associated cable.

3.4 DUCT LINES

3.4.1 Requirements

Numbers and sizes of ducts shall be as indicated. Duct lines shall be laid with a minimum slope of 4 inches per 100 feet. The minimum manufactured bend radius shall be 18 inches for ducts of less than 3 inch diameter, and 36 inches for ducts 3 inches or greater in diameter. Otherwise, long sweep bends having a minimum radius of 25 feet shall be used for a change of direction of more than 5 degrees, either horizontally or vertically. Both curved and straight sections may be used to form long sweep bends, but the maximum curve used shall be 30 degrees and manufactured bends shall be used.

3.4.2 Treatment

Ducts shall be kept clean of concrete, dirt, or foreign substances during construction. Field cuts requiring tapers shall be made with proper tools and match factory tapers. A coupling recommended by the duct manufacturer shall be used whenever an existing duct is connected to a duct of different material or shape. Ducts shall be thoroughly cleaned before being laid.

3.4.3 Concrete Encasement

Ducts requiring concrete encasement shall comply with NFPA 70. The separation between adjacent electric power and communication ducts shall conform to IEEE C2. Duct line encasements shall be monolithic construction.

Where a connection is made to a previously poured encasement, the new encasement shall be well bonded or doweled to the existing encasement. The Contractor shall submit proposed bonding method for approval in accordance with the detail drawing portion of paragraph SUBMITTALS. At any point,

tops of concrete encasements shall be not less than the cover requirements listed in NFPA 70. Separators or spacing blocks shall be made of steel, concrete, plastic, or a combination of these materials placed not farther apart than 4 feet on centers. Ducts shall be anchored to prevent movement during the placement of concrete, and joints shall be staggered at least 6 inches vertically.

3.4.4 Nonencased Direct Burial

Top of duct lines shall be not less than 36 inches below finished grade and shall be installed with a minimum of 3 inches of earth around each duct, except that between adjacent electric power and communication ducts, 12 inches of earth is required. Bottoms of trenches shall be graded toward manholes or handholes and shall be smooth and free of stones, soft spots, and sharp objects. Where bottoms of trenches comprise materials other than sand, a 3 inch layer of sand shall be laid first and compacted to approximate densities of surrounding firm soil before installing ducts. Joints in adjacent tiers of duct shall be vertically staggered for at least 6 inches. The first 6 inch layer of backfill cover shall be sand compacted as previously specified. The rest of the excavation shall be backfilled and compacted in 3 to 6 inch layers. Duct banks may be held in alignment with earth. However, high-tiered banks shall use a wooden frame or equivalent form to hold ducts in alignment prior to backfilling.

3.4.5 Installation of Couplings

Joints in each type of duct shall be made up in accordance with the manufacturer's recommendations for the particular type of duct and coupling selected and as approved.

3.5 CONNECTION BETWEEN AERIAL AND INTERIOR/UNDERGROUND SYSTEMS

Connections between aerial and underground systems shall be made as shown. The Scott-Mississippi-New Madrid Electric Coop electrical utility will make the final connection to the building service entrances, assisted by the Contractor.

Utility cables shall be supported by eyebolts constructed in the building by the Contractor. The Contractor shall coordinate the exact placement of the eyebolts with the utility to achieve the code clearances indicated on the plans.

3.6 FIELD TESTING

3.6.1 General

The Contractor shall perform tests and inspections recommended by the manufacturer unless specifically waived by the Contracting Officer. The Contractor shall maintain a written record of tests which includes date, test performed, personnel involved, devices tested, serial number and name of test equipment, and test results.

3.6.2 Safety

The Contractor shall provide and use safety devices such as rubber gloves, protective barriers, and danger signs to protect and warn personnel in the test vicinity. The Contractor shall replace any devices or equipment which are damaged due to improper test procedures or handling.

3.6.3 Medium-Voltage Cable Test

After installation and before the operating test or connection to an existing system, the medium-voltage cable system shall be given a high potential test. Direct-current voltage shall be applied on each phase conductor of the system by connecting conductors as one terminal and connecting grounds or metallic shieldings or sheaths of the cable as the other terminal for each test. Prior to making the test, the cables shall be isolated by opening applicable protective devices and disconnecting equipment. The test shall be conducted with all splices, connectors, and terminations in place. The method, voltage, length of time, and other characteristics of the test for initial installation shall be in accordance with NEMA WC 8 for the particular type of cable installed and shall not exceed the recommendations of IEEE Std 48 for cable terminations unless the cable and accessory manufacturers indicate higher voltages are acceptable for testing. Should any cable fail due to a weakness of conductor insulation or due to defects or injuries incidental to the installation or because of improper installation of cable, cable terminations, or other connections, the Contractor shall make necessary repairs or replace cables as directed. Repaired or replaced cables shall be retested at no additional cost to the government.

3.6.4 Low-Voltage Cable Test

Low-voltage cable, complete with splices, shall be tested for insulation resistance after the cables are installed, in their final configuration, ready for connection to the equipment, and prior to energization. The test voltage shall be 500 volts dc, applied for one minute between each conductor and ground and between all possible combination conductors in the same trench, duct, or cable, with all other conductors in the same trench, duct, or conduit. The minimum value of insulation shall be:

$$R \text{ in megohms} = (\text{rated voltage in kV} + 1) \times 1000 / (\text{length of cable in feet})$$

Each cable failing this test shall be repaired or replaced. The repaired cable shall be retested until failures have been eliminated.

3.7 GROUNDING

3.7.1 Ground-Resistance Tests

The resistance of the grounding grid shall be measured using the fall-of-potential method defined in IEEE Std 81. Soil resistivity in the area of the grid shall be measured concurrently with the grid measurements. Ground resistance measurements shall be made before the electrical distribution system is energized and shall be made in normally dry conditions not less than 48 hours after the last rainfall. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together below grade. The combined resistance of separate systems may be used to meet the required resistance, but the specified number of electrodes must still be provided.

- a. Single rod electrode - 25 ohms.
- b. Grid electrode - 1 ohm.

3.7.2 Ground-Grid Connection Inspection

All below-grade ground-grid connections will be visually inspected by the Contracting Officer before backfilling. The Contractor shall notify the Contracting Officer 8 hours before the site is ready for inspection.

3.8 INSTALLATION ENGINEER

After delivery of the equipment, the Contractor shall furnish one electrical field engineer, regularly employed by the equipment manufacturer to supervise the installation of the equipment, assist in the performance of the onsite tests, initial operation, and instruct personnel as to the operational and maintenance features of the equipment.

3.9 ACCEPTANCE

Final acceptance of the facility will not be given until the Contractor has successfully completed tests and after defects in installation, material or operation have been corrected.

End of Section

DIVISION 16 - ELECTRICAL

SECTION 16403

MOTOR CONTROL CENTERS

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End of Section Table of Contents

SECTION 16403

MOTOR CONTROL CENTERS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

INSTITUTE OF ELECTRICAL AND ELECTRONIC ENGINEERS (IEEE)

- | | |
|-------------|--|
| IEEE C12.11 | (1987) Instrument Transformers for Revenue Metering, 10 kV BIL Through 350 kV (0.6 kV NSV Through 69 kV NSV) |
| IEEE C57.13 | (1993) Instrument Transformers |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

- | | |
|------------|---|
| NEMA AB 1 | (1993) Molded Case Circuit Breakers and Molded Case Switches |
| NEMA ICS 1 | (1993) Industrial Control and Systems |
| NEMA ICS 2 | (1993) Industrial Control Devices, Controllers and Assemblies |
| NEMA ICS 4 | (Rev 1, 1997) Industrial Control and Systems Terminal Blocks |
| NEMA ICS 6 | (1993) Industrial Control and Systems Enclosures |
| NEMA ST 1 | (R1994) Specialty Transformers (Except General Purpose Type) |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

- | | |
|---------|---------------------------------|
| NFPA 70 | (1999) National Electrical Code |
|---------|---------------------------------|

UNDERWRITERS LABORATORIES (UL)

- | | |
|-------|--|
| UL 44 | (1999) Rubber- Insulated Wires and Cables |
| UL 50 | (1995) Enclosures for Electrical Equipment |

UL 489	(1996) Molded Case Circuit Breakers and Circuit Breaker Enclosures
UL 845	(1995) Motor Control Centers
UL 1063	(1998) Machine-Tool Wires and Cables

1.2 SYSTEM DESCRIPTION

These specifications include the design, fabrication, assembly, wiring, testing, and installation of the items of equipment and accessories and spare parts listed in the Schedule and shown on the drawings.

1.2.1 Rules

The equipment shall conform to the requirements of NFPA 70 unless more stringent requirements are indicated herein or shown. NEMA rated and UL listed equipment has been specified when available. Equipment must meet NEMA and UL construction and rating requirements as specified. No equivalent will be acceptable. The Contractor shall immediately notify the Contracting Officer of any requirements of the specifications or Contractor proposed materials or assemblies that do not comply with UL or NEMA. International Electrotechnical Commission (IEC) rated equipment will not be considered an acceptable alternative to specified NEMA ratings.

1.2.2 Coordination

The general arrangement of the motor control centers, switchboards and panelboards is shown on the contract drawings. Any modifications of the equipment arrangement or device requirements as shown on the drawings shall be subject to the approval of the Contracting Officer. If any conflicts occur necessitating departures from the drawings, details of and reasons for departures shall be submitted and approved prior to implementing any change. All equipment shall be completely assembled at the factory. The motor control centers and switchboards may be disassembled into sections, if necessary, for convenience of handling, shipping, and installation.

1.2.3 Standard Products

Material and equipment shall be standard products of a manufacturer regularly engaged in their manufacture and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. All materials shall conform to the requirements of these specifications. Materials shall be of high quality, free from defects and imperfections, of recent manufacture, and of the classification and grades designated. All materials, supplies, and articles not manufactured by the Contractor shall be the products of other recognized reputable manufacturers. If the Contractor desires for any reason to deviate from the standards designated in these specifications, he shall, after award, submit a statement of the exact nature of the deviation, and shall submit, for the approval of the Contracting Officer, complete specifications for the materials which he proposes to use.

1.2.4 Nameplates

Nameplates shall be made of laminated sheet plastic or of anodized aluminum approximately 4 millimeters (1/8 inch) thick, engraved to provide white letters on a black background. The nameplates shall be fastened to the panels in proper positions with anodized round-head screws. Lettering shall be minimum 15 millimeters (1/2 inch) high. Nameplate designations shall be in accordance with lists on the drawings, and as a minimum shall be provided for the following equipment:

- a. Motor Control Centers
- b. Individual items of equipment mounted in the Motor Control Centers
- c. Fused Switches
- d. Warning sign for multiple services

Equipment of the withdrawal type shall be provided with nameplates mounted on the removable equipment in locations visible when the equipment is in place.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation. Equipment, materials, and articles installed or used without such approval shall be at the risk of subsequent rejection. Submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Equipment; GA.

The Contractor shall within 30 calendar days after date of award submit for approval six (6) copies of such descriptive cuts and information as are required to demonstrate fully that all parts of the equipment will conform to the requirements and intent of the specifications. Data shall include descriptive data showing typical construction of the types of equipment proposed, including the manufacturer's name, type of molded case circuit breakers or motor circuit protectors, performance capacities and other information pertaining to the equipment. Six (6) sets of characteristic curves of the individual breaker trip element shall be submitted.

SD-04 Drawings

Outline Drawings; GA.

The Contractor shall, within 30 calendar days after date of award, submit for the approval of the Contracting Officer six (6) copies of outline drawings of all equipment to be furnished under this contract, together with weights and overall dimensions. Drawings shall show the general arrangement and overall dimensions of the motor control centers, switchboards, and panelboards. These drawings shall show space requirements, details of any floor supports to be embedded in concrete and provisions for conduits for external cables.

Motor Control Center; GA.

The Contractor shall, within 30 calendar days after date of award, submit for the approval of the Contracting Officer six (6) copies of electrical equipment drawings. The NEMA Class I B motor control center drawings shall include a connection diagram with wire designations and schematic diagrams to illustrate operation of associated motor unit controls. An individual wiring diagram for each motor control center compartment shall be submitted. A single-line diagram, equipment list and nameplate schedule shall be provided for each motor control center.

SD-09 Reports

Factory Tests; FIO.

The Contractor shall submit six (6) complete reproducible copies of the factory inspection results and six (6) complete reproducible copies of the factory test results in booklet form, including all plotted data curves, all test conditions, a listing of test equipment complete with calibration certifications, and all measurements taken. Report shall be signed and dated by the Contractor's and Contracting Officer's Representatives.

1.4 DELIVERY, STORAGE, AND HANDLING

The equipment shall be shipped as completely assembled and wired as feasible so as to require a minimum of installation work. Each shipping section shall be properly match-marked to facilitate reassembly, and shall be provided with removable lifting channels with eye bolts for attachment of crane slings to facilitate lifting and handling. Any relay or other device which cannot withstand the hazards of shipment when mounted in place on the equipment shall be carefully packed and shipped separately. These devices shall be marked with the number of the panel which they are to be mounted on and fully identified. All finished painted surfaces and metal work shall be wrapped suitably or otherwise protected from damage during shipment. All parts shall be prepared for shipment so that slings for handling may be attached readily while the parts are in a railway car or transport truck. All spare parts and accessories shall be carefully packaged and clearly marked.

1.5 MAINTENANCE

1.5.1 Accessories and Tools

A complete set of accessories and special tools unique to equipment provided and required for erecting, handling, dismantling, testing and maintaining the apparatus shall be furnished by the Contractor. Furnish a electrically insulating floor mat for the operator's protection in front of the Motor Control Center. The mat shall be 30 inches wide by the length of the housekeeping pad.

1.5.2 Spare Parts

Spare parts shall be furnished as specified below. All spare parts shall be of the same material and workmanship, shall meet the same requirements, and shall be interchangeable with the corresponding original parts furnished.

- a. 6 - Fuses of each type and size.
- b. 1 - Circuit breaker auxiliary switch.
- c. 2 - Operating coils for each size ac contactor.
- d. 2 - Complete sets of 3-pole stationary and moving contact assemblies for each size ac contactor.
- e. 3 - Contactor overload relays of each type and rating, each relay with a complete set of contact blocks.
- f. 1 - Spare set of heater elements for each heater rating provided.

- g. 2 - Indicating lamp assemblies of each type.
- h. 1 - Control relay of each type and rating.
- i. 1 - Contactor auxiliary contact of each type.
- j. 4 - One quart containers of finish paint for indoor equipment.
- k. 4 - Keys for motor control center door lock.

PART 2 PRODUCTS

2.1 CONNECTIONS

The sizes and threads of all conduit and fittings, tubing and fittings, and connecting equipment shall be in accordance with English Standards. All ferrous fasteners shall have rust-resistant finish and all bolts and screws shall be equipped with approved locking devices. Manufacturer's standard threads and construction may be used on small items which, in the opinion of the Contracting Officer, are integrally replaceable, except that threads for external connections to these items shall meet the above requirements.

2.2 FUSIBLE SWITCHES

Fusible switch shall conform to the applicable requirements of NEMA AB 1 and UL 489. The Switch shall be manually-operated, shall be quick-make, quick-break, common trip type, and shall be of rejection fuse type unless otherwise specified or indicated on the drawings. All poles of each switch shall be operated simultaneously by means of a common handle. The operating handles shall clearly indicate whether the breakers are in "On," "Off," or "Tripped" position and shall have provisions for padlocking in the "Off" position. Personnel safety line terminal shields shall be provided for each switch. The switches shall be products of only one manufacturer, and shall be interchangeable when of the same frame size.

2.2.1 Key Interlock

The main fused disconnect shall be key interlocked with the emergency power disconnect switch as indicated on the plans. The interlock scheme shall require a key to be inserted and be retained in order to close the main switch of the Motor Control Center. The intent is to allow closure of only one switch feeding the Motor Control Center to prevent simultaneous closure of the two main switches. The key interlock mechanism shall be of the same manufacturer for both switches. Refer to SECTION 16415 for the disconnect switch requirements.

2.2.2 Fuses

Except as otherwise noted, the fuses, of the unit ratings as shown on the drawings, shall be provided. The Government reserves the right to change the indicated fuse ratings, within frame limits, of the trip devices at the time the shop drawings are submitted for approval.

Equipment provided under this contract shall be provided with a complete set of properly rated fuses when the equipment manufacturer utilize fuses in the manufacture of the equipment, or if current-limiting fuses are required to be installed to limit the ampere-interrupting capacity of circuit breakers or

equipment to less than the maximum available fault current at the location of the equipment to be installed. Fuses shall have a voltage rating of not less than the phase-to-phase circuit voltage, and shall have the time-current characteristics required for effective power system coordination. Time-delay and options shall be as specified and required by the coordination study.

2.2.3 Cartridge Fuses; Current-Limiting Type

Cartridge fuses, current-limiting type, Class RK5 shall have tested interrupting capacity not less than 200,000 amperes. Fuse holders shall be the type that will reject all Class H fuses.

2.2.4 Continuous Current Ratings (Greater than 600 Amperes)

Service entrance and feeder circuit fuses (greater than 600 amperes) shall be Class L, current-limiting, time-delay with 200,000 amperes interrupting capacity.

2.2.5 Motor and Transformer Circuit Fuses

Motor, motor controller, transformer, and inductive circuit fuses shall be Class RK5, current-limiting, time-delay with 200,000 amperes interrupting capacity.

2.2.6 Coordination

The fuses supplied shall be demonstrated in the coordination study in Section 16475 COORDINATED POWER SYSTEM PROTECTION to coordinate, indicating that the fuse nearest the fault clears the fault before the upstream fuses opens.

2.3 WIRING

All control wire shall be stranded tinned copper switchboard wire with 600-volt flame-retardant insulation Type SIS meeting UL 44 or Type MTW meeting UL 1063, and shall pass the VW-1 flame tests included in those standards. Hinge wire shall have Class K stranding. Current transformer secondary leads shall be not smaller than No. 10 AWG. The minimum size of control wire shall be No. 14 AWG. Power wiring for 480-volt circuits and below shall be of the same type as control wiring and the minimum size shall be No. 12 AWG. Special attention shall be given to wiring and terminal arrangement on the terminal blocks to permit the individual conductors of each external cable to be terminated on adjacent terminal points.

2.4 TERMINAL BLOCKS

Control circuit terminal blocks for control wiring shall be molded or fabricated type with barriers, rated not less than 600 volts. The terminals shall be removable binding, fillister or washer head screw type, or of the stud type with contact and locking nuts. The terminals shall be not less than No. 10 in size and shall have sufficient length and space for connecting at least two indented terminals for 10 AWG conductors to each terminal. The terminal arrangement shall be subject to the approval of the Contracting Officer and not less than four (4) spare terminals or 10 percent, whichever is greater, shall be provided on each block or group of blocks. Modular, pull apart, terminal blocks will be acceptable provided they are of the channel or rail-mounted type. The Contractor shall submit data showing that the proposed alternate will accommodate the specified number of wires, are of adequate current-carrying capacity, and are constructed to assure positive contact between current-carrying parts.

2.4.1 Types of Terminal Blocks

2.4.1.1 Short-Circuiting Type

Short-circuiting type terminal blocks shall be furnished for all current transformer secondary leads and shall have provision for shorting together all leads from each current transformer without first opening any circuit. Terminal blocks shall meet the requirements of paragraph TERMINAL BLOCKS above.

2.4.1.2 Load Type

Load terminal blocks rated not less than 600 volts and of adequate capacity shall be provided for the conductors for NEMA Size 3 and smaller motor controllers and for other power circuits except those for feeder tap units. The terminals shall be of either the stud type with contact nuts and locking nuts or of the removable screw type, having length and space for at least two indented terminals of the size required on the conductors to be terminated. For conductors rated more than 50 amperes, screws shall have hexagonal heads. Conducting parts between connected terminals shall have adequate contact surface and cross-section to operate without overheating. Each connected terminal shall have the circuit designation or wire number placed on or near the terminal in permanent contrasting color.

2.4.2 Marking Strips

White or other light-colored plastic marking strips, fastened by screws to each terminal block, shall be provided for wire designations. The wire numbers shall be made with permanent ink. The marking strips shall be reversible to permit marking both sides, or two marking strips shall be furnished with each block. Marking strips shall accommodate the two sets of wire numbers. Each device to which a connection is made shall be assigned a device designation in accordance with NEMA ICS 1 and each device terminal to which a connection is made shall be marked with a distinct terminal marking corresponding to the wire designation used on the Contractor's schematic and connection diagrams. The wire (terminal point) designations used on the Contractor's wiring diagrams and printed on terminal block marking strips may be according to the Contractor's standard practice; however, additional wire and cable designations for identification of remote (external) circuits shall be provided for the Government's wire designations. Prints of drawings submitted for approval will be so marked and returned to the Contractor for addition of the designations to the terminal strips and tracings, along with any rearrangement of points required.

2.5 SPACE HEATERS

Space heaters shall be provided where indicated on the drawings and shall be controlled using an adjustable 10 to 35 degree C (50 to 90 degree F) thermostat, magnetic contactor, and a molded-case circuit breaker. The space heaters shall be strip elements operated at 120 volts and shall be wired to terminal blocks for connection to 120-volt single-phase power sources located external to the control centers.

2.6 MOTOR CONTROL CENTERS

Each motor control center shall be designed for operation on 480-volts ac, 3-phase, 60-Hz system, and the equipment shall conform to all the applicable requirements of NEMA ICS 1, NEMA ICS 2, NEMA ICS 4 and NEMA ICS 6. Vertical sections and individual units shall be listed and labeled under UL 845 where ever possible. In lieu of the UL listing, certification from any nationally recognized, adequately equipped, testing agency that the individual units and vertical sections have been tested and conform to the UL requirements of that agency will be acceptable when approved by the Contracting

Officer. The motor control center shall be NEMA Class I, Type B, motor control centers in accordance with NEMA ICS 2.

2.6.1 Enclosures

Each motor control center shall consist of the required number of vertical sections of 2250 millimeters (90 inches) nominal height, bolted together, with steel channel sills and suitable for mounting against a wall. Vertical section shall be 510 millimeters (20 inches) deep and buses, control wiring, control transformers, small power transformers, terminal blocks, line terminals, cable supports, and clamps shall be accessible from the front. Enclosure shall be NEMA Type 1 gasketed. The control centers shall be fabricated from smooth select steel sheets shaped and reinforced to form rigid free-standing structures. Metal thickness for enclosures shall be not less than specified in NEMA ICS 6 without exception. Vertical edges of sections exposed to view shall be so fabricated and bolted that the joints will not pass a 1.6 millimeter (1/16 inch) gage. Each structure shall be designed for addition of future sections required. Individual compartments shall be isolated from adjacent compartments.

2.6.1.1 Unit Compartments

Each operating unit shall contain equipment as shown on the drawings, mounted in an individual cell. The unit assembly, except main circuit breakers, panelboards and auxiliary control devices, shall be drawout type removed from the front, without rear access or disturbing other units in the control center assembly. All drawout type unit assemblies shall have positive guide rail system to ensure alignment of connection to vertical bus. Units shall be mechanically interlocked with the door to prevent removal while in the energized position. Each removable unit shall have provision for padlocking in a position in which it is disconnected from the vertical bus although not removed from the stationary structure. All ventilating openings shall be provided with corrosion-resistant insect-proof screens on the inside. Bus closing plugs shall be provided for all unused openings in vertical bus barriers.

2.6.1.2 Motor Control Center Doors and Covers

Each unit compartment, including blank compartments for future use, shall be provided with either a flange-formed or a rolled-edge door. Each door shall be mounted on fully-concealed or continuous full-length piano-type hinges and shall be provided with positive fasteners. Door sag shall be prevented by proper alignment of hinges made of sufficiently strong material. The door fastenings shall be so interlocked to prevent opening when the equipment is energized. The external operating handle shall clearly indicate whether the equipment is in an "ON", "OFF" or "TRIPPED" position.

2.6.1.3 Seismic Requirements

The motor control center, when anchored per the manufacturer's recommendations and installation instructions, shall withstand specified horizontal and vertical accelerations without overturning or lateral movement. The manufacturer shall include in the submittals all the weights and securing features required for installation to these requirements. This equipment shall be designed for installation in a Seismic Hazard Exposure Group "II" Seismic Zone 3 with $A_v = 0.30$ and in accordance with requirements of Section 05900 SEISMIC PROTECTION FOR MECHANICAL, ELECTRICAL EQUIPMENT AND SUSPENDED CEILING SYSTEMS.

The seismic qualification does not, however, indicate that the motor control center equipment will operate properly during or after a seismic event; however, the internal components shall not damage themselves or adjacent internal equipment during a seismic event of the magnitude indicated.

Similarly, the equipment enclosure shall be braced to withstand the event, without permanent deformation.

2.6.1.4 Horizontal Wireways

Structure shall have a minimum 150 millimeters (6 inches) high wireway at the top and a 300 millimeters (12 inches) minimum wireway at the bottom. Both horizontal wireways shall run the length of the structure. Cover plates shall be provided on the side of the assembly to permit extension of the horizontal bus and wireway when vertical sections are added.

2.6.1.5 Vertical Wireways

Vertical wireways shall be provided in all vertical sections accepting multiple plug-in components. Vertical wireways shall connect with horizontal wireways at the top and bottom and be a minimum 100 millimeters (4 inches) wide. Barriers shall be provided in sections containing both ac and dc vertical buses. Doors shall be provided on each vertical wireway. The exposed surface of any door shall not deviate more than 1.5 millimeters (1/16-inch) from a true plane.

2.6.1.6 Sills

Channel iron foundations, complete with bolts and drilled holes for grouting and anchoring to the floor, shall be furnished for the complete length (front and rear) of each motor control center assembly. The channels shall be designed for flat mounting and maximum channel depth shall be 60 millimeters (2-1/2 inches). Additional channel or substantial metal trim shall be provided flush with the end panels to completely enclose the bases across the ends of the equipment assemblies.

2.6.1.7 Shutters

Drawout units shall have shutters which close when the unit is withdrawn to isolate the vertical bus.

2.6.1.8 Thermostatically Controlled Strip Heaters

Thermostatically controlled strip heaters as specified in paragraph SPACE HEATERS shall be provided in all motor control centers.

2.6.2 Buses

All buses shall be of copper and shall be tin or silver-plated throughout. All splices for field assembly shall be bolted with at least two bolts and shall employ the use of "Belleville" washers in the connection. The bus ratings shall be based on a 65 degree Celsius maximum temperature rise in accordance with UL 845 requirements. Bus shall have a short-circuit current rating of not less than 65,000 RMS symmetrical amperes. All bus work shall be supported on wet process porcelain insulators, glass polyester, or suitable molded material.

2.6.2.1 Horizontal Bus

Each control center assembly shall be provided with a three-phase main horizontal bus, with a continuous current rating not less than 800 amperes, located across the top of each vertical section. The ends of horizontal buses shall be drilled for future extensions.

2.6.2.2 Vertical Bus

Each vertical section shall be provided with a three-phase vertical bus with a continuous current rating of 300 amperes connected to the horizontal bus by brazing, welding, or bolting. Where the incoming feeder breakers are located at the bottom of a control center, the vertical bus in that section shall be rated the same as the main horizontal bus. Vertical buses shall extend from the horizontal bus to the bottom of the lowest available unit mounting space. The vertical bus shall be isolated from wireways and equipment in compartments.

2.6.2.3 Ground Bus

A copper ground bus shall be provided full width at the bottom of the motor control center line-up. A full clamp-type solderless copper or copper alloy lug for No. 2/0 AWG stranded copper cable shall be provided at each end of the bus for connection to the station grounding system.

2.6.2.4 Neutral Bus

A half rated neutral bus shall be furnished continuous through the control center. Lugs of appropriate capacity will be furnished.

2.6.3 Combination Starters

Combination motor controller units shall contain fused switches, auxiliary and pilot devices and a magnetic contactor with thermal overload relays where indicated on the drawings. The ratings of fuse switches, contactors, motor controllers and other devices shall be as shown on the drawings. All combination motor controller units shall have short circuit ratings equal to 65,000 amperes or greater. Where control push-buttons, indicating lamps, "Hand-Off-Automatic" switches, and similar control devices are associated with a unit, they shall be mounted on the unit compartment door. Door-mounted components shall not interfere with access within the compartments.

2.6.3.1 Magnetic Contactors

Magnetic contactors shall be of the NEMA sizes indicated on the drawings. The rating, performance and service characteristics shall conform to the requirements of NEMA ICS 2 for contactors with continuous current ratings for the duty indicated. Contactors for motor control shall be rated for full-voltage starting (Class A controllers). Contactors shall be suitable for at least 200,000 complete operations under rated load without more than routine maintenance. The interruption arc and flame shall be minimized by suitable arc chutes or other means so that no damage will be done to other portions of the device. The arc chutes, if provided, shall be easily removable without removing or dismantling other parts. The contacts shall be easily removable. All current-carrying contact surfaces shall be silver-surfaced or of other approved material to prevent the formation of high resistance oxides. The contactor shall operate without chatter or perceptible hum while energized. Coils shall be suitable for continuous operation 120-volt ac circuits. Alternating-current contactors shall be three-pole, except where otherwise noted, and shall be insulated for 600 volts ac and of the electrically-operated, electrically-held type.

2.6.3.2 Auxiliary Contacts

Each controller shall be provided with a minimum of three auxiliary contacts which can be easily changed from normally open to normally closed. Where indicated on the drawings, a fourth auxiliary contact and red and green indicating lights shall be provided.

2.6.3.3 Overload Relays

Except as otherwise indicated, each controller shall be provided three NEMA Class 20 thermal overload relays with external manual reset. Prior to shipment of the control centers, the Contracting Officer will furnish the ratings of the heater elements to be installed in the relays by the Contractor.

2.6.3.4 Individual Control Transformers

Where 120 volt ac control of contactors is indicated or required, individual control transformer shall be provided on the line side of the unit disconnect. The control transformers shall be rated 480-120 volts and shall conform to the requirements for control transformers in NEMA ST 1. Control transformers shall have 200 percent volt-ampere capacity for the control functions indicated. Transformers shall be installed with primary fuses. Except as otherwise indicated on the drawings, each control transformer shall be provided with a fuse in one secondary lead and shall have the other secondary lead grounded.

2.6.3.5 Voltage Fault Protection

Where shown, starters shall be provided with protection against voltage faults, phase unbalance, phase loss, phase reversal, and undervoltage. Upon sensing one of these faults, the protector shall de-energize the starter. The protector shall use a combination of voltage and phase-angle sensing to detect phase loss even when regenerated voltages are present. The protector shall be connected to the load side of the motor circuit disconnect. The protector shall have an adjustable line voltage trip level, adjustable trip delay, automatic reset and manual bypass by an external normally closed push-button, and output contacts. Protector operation shall have repeatability of +1 percent of set point, maximum, and a dead band of 2 percent maximum. Protector shall have green indicator to show normal status and red indicator to show tripped status.

2.6.3.6 Control Circuit Disconnects

Control circuit power shall disconnect when the unit compartment is opened.

2.6.4 Fusible Switches in Unit Compartments

Fusible switches for installation in unit compartments shall meet the requirements of NEMA ICS 2 and UL 50 and UL 845. The switch shall be lockable in the "ON" and "OFF" position and shall reject class H fuses. The door shall be interlocked mechanically with the operator handle to prevent opening the door when the switch is closed.

2.6.5 Wiring for Motor Control Center

All wiring shall meet the requirements of paragraph WIRING above. Heavy-duty clamp type terminals shall be provided by the Contractor for terminating all power cables entering the control centers.

2.6.5.1 Contractor's Wiring

The Contractor's wiring shall be formed into groups, suitably bound together, properly supported and run straight, horizontally or vertically. There shall be no splices in the wiring. The manufacturer's standard pressure-type wire terminations for connections to internal devices will be acceptable. Terminal blocks shall be added for wiring to devices having leads instead of terminals. Ring tongue indented terminals shall be used on all wires terminated on control terminal blocks for external or

interpanel connections and at shipping splits. All stud terminals shall have contact nuts and either locking nuts or lockwashers.

2.6.5.2 External Connections

Power and control cables will enter the control centers where shown on the drawings.

2.6.6 Accessories and Control Devices

Control accessories shall be provided, and shall be suitable for mounting on the front of, or inside, the control centers as indicated on the drawings. Control accessories shall meet the applicable requirements of NEMA ICS 2. Relays and other equipment shall be so mounted that mechanical vibration will not cause false operation.

2.6.6.1 Control Stations

Push-button stations and selector switches shall conform to NEMA ICS 2, shall be of the heavy-duty, oil-tight type, rated 600 volts ac, and have a contact rating designation of A600. Switches shall be provided with escutcheon plates clearly marked to show operating positions. Sufficient contact blocks shall be provided to make up the electrically separate contacts required for lead-lag selector switches.

2.6.6.2 LED Indicating Lights

Red and green LED's shall be furnished where shown on the drawings, indicating contact "open" and "closed" position. The LED's shall be accessible and replaceable from the front of the control center through a finished opening in the compartment door. The LED assemblies shall be of the heavy duty oil-tight, watertight, and dust-tight type. Lamps shall have push-to-test feature.

2.6.6.3 Control Relays

Control relays shall be of the electrically operated, magnetically held, self-reset, open type, suitable for mounting inside the starter compartments, and shall be 120-volt ac. Contacts shall be as indicated on the drawings and shall have a contact rating designation of A600 or N600, as required, in accordance with NEMA ICS 2.

2.6.6.4 Timing Relays

Timers shall be electronic with timing indication and LED status type. They shall be suitable for mounting inside the control center and shall be rated 120 volts ac, 60 Hz. Instantaneous and time delay contacts shall be provided as indicated on the drawings, and shall have a contact rating designation of A600 or N600, as required, in accordance with NEMA ICS 2. Means shall be provided for adjustment over a range as indicated on the drawings.

2.6.6.5 Elapsed-Time Meters

Hour-indicating time meters shall have 6- digit registers with counter numbers at least 7 millimeters (1/4 inch) high. White numbers on black backgrounds shall provide hour indication with the last digit in contrasting colors to indicate tenths of an hour. The enclosure shall be 90 millimeters (3-1/2 inches) square and dust resistant. Operating voltage shall be 120 volts ac. They shall be of the nonreset type.

2.6.7 Feeder Tap Units

Feeder tap units shall be provided as indicated on the drawings.

2.6.8 Metering Section

Multifunction meters shall be furnished and installed for the motor control center as indicated. The meter shall have dual RS-485 communications output ports with Modbus RTU protocol for data transmission to host computer device and a single RS-232 port on the front for laptop computer connection. The meter shall provide the following features:

- a. The meter shall be capable of displaying:
 - (1) Three phase voltages and amperes
 - (2) VA, Kilowatts, Kilovars
 - (3) Varhour, Watthours
 - (4) A, W, var, and VA demands
 - (4) Power Factor
 - (5) Frequency
 - (5) Harmonic analysis through the 63rd with THD and TIF
 - (6) VI unbalance
 - (7) True PF crest and K factor
- b. Voltage and current shall be sampled 64 times per cycle for 0.2% accuracy true RMS measured values.
- c. Actual values shall be displayed with illuminated 40 character LCD display and access by front panel keypad which can be used to program setpoints.
- d. Provide 3 output relays and 4 inputs which are user definable.
- e. The manufacturer shall integrate the control requirements and sequences indicated on the drawings.
- f. The meter manufacturer shall warrant the equipment for use in the ambient conditions that will be encountered. Provide all required appurtenances for reliable operation in non-conditioned ventilated spaces.
- g. Each meter and current transformer system shall be field tested as a unit in its final configuration and installed position by injecting simulated high current through the current transformers with a current test set. Contractor shall follow manufacturer's recommended test procedures.
- h. The meter shall be Multilin PQM Power Quality Meter or equal. The meter shall be mounted on the door of the low voltage compartment for easy access.

Metering section shall be provided with multifunction instruments as indicated on the drawings. The relay manufacturer shall warrant his equipment for use in the ambient conditions that will be encountered. Provide all required appurtenances for reliable operation in non-conditioned ventilated spaces.

2.6.8.1 Instrument Transformers

All transformers used for metering shall meet the requirements of IEEE C12.11 and IEEE C57.13. Voltage transformers shall be protected with removable primary and secondary fuses. Fuses shall be installed in each ungrounded lead and located adjacent to the transformers in an easily accessible place. If cable connections to current transformer primary are required, terminals of an approved solderless type and proper size shall be furnished. If current transformers are connected to buses, proper connections shall be furnished, complete with bolts, nuts, washers and other accessories.

2.7 PAINTING

Interior and exterior steel surfaces of equipment enclosures shall be thoroughly cleaned and then receive a rust-inhibitive phosphatizing or equivalent treatment prior to painting. Exterior surfaces shall be free from holes, seams, dents, weld marks, loose scale or other imperfections. Interior surfaces shall receive not less than one coat of corrosion-resisting paint in accordance with the manufacturer's standard practice. Exterior surfaces shall be primed, filled where necessary, and given not less than two coats baked enamel with semi-gloss finish. Equipment located indoors shall be ANSI Light Gray. All touch-up work shall be done with manufacturer's coatings as supplied under paragraph SPARE PARTS.

2.8 FACTORY TESTS

Each item of equipment supplied under this contract shall be given the manufacturer's routine factory tests and tests as specified below, to insure successful operation of all parts of the assemblies. All tests required herein shall be witnessed by the Contracting Officer unless waived in writing, and no equipment shall be shipped until it has been approved for shipment by the Contracting Officer. The Contractor shall notify the Contracting Officer a minimum of 14 days prior to the proposed date of the tests so that arrangements can be made for the Contracting Officer to be present at the tests. The factory test equipment and the test methods used shall conform to the applicable NEMA Standards, and shall be subject to the approval of the Contracting Officer. Reports of all witnessed tests shall be signed by witnessing representatives of the Contractor and Contracting Officer. The cost of performing all tests shall be borne by the Contractor.

2.8.1 Motor Control Centers Tests

2.8.1.1 Dielectric Tests

Each motor control center shall be completely assembled and given dielectric tests in accordance with NEMA ICS 1.

2.8.1.2 Operational Tests

The correctness of operation of each fused switch and magnetic contactor and of all control devices, accessories and indicating lamps, shall be checked. These checks shall be made at rated voltage with power supplies to the main buses. All magnetic contactors shall also be checked for proper operation with power at 80 percent of rated voltage.

PART 3 EXECUTION

3.1 FIELD TESTING

Field testing shall be performed in the presence of the Contracting Officer. The Contractor shall notify the Contracting Officer 10 days prior to conducting tests. The Contractor shall furnish all materials, labor, and equipment necessary to conduct field tests. The Contractor shall perform all tests and inspection recommended by the manufacturer unless specifically waived by the Contracting Officer. The Contractor shall maintain a written record of all tests which includes date, test performed, personnel involved, devices tested, serial number and name of test equipment, and test results. All field test reports will be signed and dated by the Contractor.

3.1.1 Safety

The Contractor shall provide and use safety devices such as rubber gloves, protective barriers, and danger signs to protect and warn personnel in the test vicinity. The Contractor shall replace any devices or equipment which are damaged due to improper test procedures or handling.

3.1.2 Cable Tests

The Contractor shall be responsible for identifying all equipment and devices that could be damaged by application of the test voltage and ensuring that they have been properly disconnected prior to performing insulation resistance testing. An insulation resistance test shall be performed on all low and medium voltage cables after the cables are installed in their final configuration and prior to energization. The test voltage shall be 500 volts DC applied for one minute between each conductor and ground and between all possible combinations of conductors. The minimum value of resistance shall be:

$$R \text{ in megohms} = (\text{rated voltage in kV} + 1) \times 1000 / (\text{length of cable in feet})$$

Each cable failing this test shall be repaired or replaced. The repaired cable system shall then be retested until failures have been eliminated.

3.1.3 Low Voltage Cable Tests

- a. Continuity test.
- b. Insulation resistance test.

3.1.4 Service Entrance Tests

- a. Insulation Resistance phase-to-phase, all combinations.
- b. Insulation resistance phase-to-ground, each phase.
- c. AC or DC high-potential test.
- d. Phase rotation test.

3.1.5 Motor Tests

- a. Phase rotation test to ensure proper directions.

- b. Operation and sequence of reduced voltage starters.
- c. High potential test on each winding to ground.
- d. Insulation resistance of each winding to ground.
- e. Vibration test.
- f. Dielectric absorption test on motor and starter.

3.1.6 Dry-Type Transformer Tests

The following field tests shall be performed on all dry-type transformers.

- a. Insulation resistance test phase-to-ground, each phase.
- b. Turns ratio test.
- c. Tap settings for proper voltage

3.1.7 Pre-Operational Test

3.1.7.1 Fused Switch Tests

- a. Insulation resistance test phase-to-phase, all combinations.
- b. Insulation resistance test phase-to-ground, each phase.
- c. Manual operation of the switch.

3.1.8 Motor Control Centers

- a. Insulation resistance test phase-to-phase, all combinations.
- b. Insulation resistance test phase-to-ground, each phase.
- c. Manual and electrical operational tests.

3.1.9 Protective Relays

Protective relays shall be visually and mechanically inspected, adjusted, tested, and calibrated in accordance with the manufacturer's published instructions. These tests shall include pick-up, timing, contact action, restraint, and other aspects necessary to insure proper calibration and operation. Relay contacts shall be manually or electrically operated to verify that the proper control action and alarms initiate.

3.2 OPERATING TESTS

After the installation is completed, and at such time as the Contracting Officer may direct, the Contractor shall conduct operating tests for approval of the installation. The equipment shall be demonstrated to operate in accordance with the specified requirements. The Contractor shall submit for

approval a test procedure and forms for recording the results of the tests. An operating test report shall be submitted to the Contracting Officer following the test.

Test Forms are appended to SECTION 16415, APPENDIX 1 - MOTOR CERTIFICATION DATA. These forms shall be filled out for each individual motor, signed and submitted as specified.

Upon commissioning, fill out the test forms. Upon starting the motor for the first time, record the protective relay metering data.

After each multifunction relay has been properly set and tested, the Contractor shall download the configuration of each relay to an electronic file. This may be accomplished with an IBM compatible personal computer and an RS-485/RS-232 protocol converter. The converter, download software, and connecting cables shall become the property of the Government. These configuration files shall be stored on 3.5" diskettes which are formatted using Excel compatible format. The Contractor shall affix type-written labels to each diskette with the filenames and associated pump names on the label. Three (3) duplicate copies of each diskette shall be submitted to the Contracting Officer.

3.3 FIELD SERVICE

3.3.1 On-site Training

The Contractor shall conduct a training course for the operating staff as designated by the Contracting Officer. The training period shall consist of a total of 16 hours of normal working time and shall start after the system is functionally completed but prior to final acceptance tests. The course instruction shall cover pertinent points involved in operating, starting, stopping, servicing the equipment, as well as all major elements of the operation and maintenance manuals. Additionally, the course instructions shall demonstrate all routine maintenance operations. A VHS format videotape of the entire training shall be submitted.

3.3.2 Installation Engineer

After delivery of the equipment, the Contractor shall furnish one or more field engineers, regularly employed by the equipment manufacturer to supervise the installation of equipment, assist in the performance of the onsite tests, oversee initial operations, and instruct personnel as to the operational and maintenance features of the equipment.

3.4 ACCEPTANCE

Final acceptance of the facility will not be given until the Contractor has successfully completed all tests and after all defects in installation, material or operation have been corrected.

3.4.1 Start-Up Service

The supplier of the motor controller described herein shall have a factory trained service representative in domestic residence within 150 miles (average) of the job site. The factory representative shall be trained in the maintenance and troubleshooting of the equipment as specified herein.

Start-up service is to be included for a period of not less than 35 hours, but in no case less than the time required to satisfactorily commission and operate the pump controllers.

3.4.2 Documentation

Six (6) Instruction Manuals, along with three (3) sets of schematic diagrams, shall be provided with the controller at time of shipment.

3.4.3 Spare Parts

Recommended spare parts list shall be furnished with the equipment as listed and approved with the shop drawings. Also, the address of the manufacturer's closest parts stocking location shall be provided.

End of Section

DIVISION 16 - ELECTRICAL

SECTION 16405

MEDIUM VOLTAGE ELECTRICAL SYSTEM

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SECTION 16405

MEDIUM VOLTAGE ELECTRICAL SYSTEM

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

INSTITUTE OF ELECTRICAL AND ELECTRONIC ENGINEERS (IEEE)

IEEE C12.1	(1988) Code for Electricity Metering
IEEE C12.11	(1987) Instrument Transformers for Revenue Metering, 10 kV BIL Through 350 kV (0.6 kV NSV Through 69 kV NSV)
IEEE C37.20.2	(1993) Standard for Metal Clad and Station-Type Cubicle Switchgear
IEEE C37.23	(1987) Guide for Metal-Enclosed Bus and Calculating Losses in Isolated-Phase Bus
IEEE C57.13	(1993) Instrument Transformers

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA BU 1	(1994) Busways
NEMA ICS 1	(1993) Industrial Control and Systems
NEMA ICS 2	(1993) Industrial Control Devices, Controllers and Assemblies
NEMA ICS 3	(1993) Industrial Control Devices, Factory Built Assemblies
NEMA ICS 4	(1993)Rev. 1997 Industrial Control and Systems Terminal Blocks
NEMA ICS 6	(1993) Industrial Control and Systems Enclosures
NEMA ST 1	(1988) Specialty Transformers (Except General Purpose Type)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(1999) National Electrical Code
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UNDERWRITERS LABORATORIES (UL)

UL 44	(1999) Rubber- Insulated Wires and Cables
UL 50	(1995) Enclosures for Electrical Equipment
UL 347	(1993) High Voltage Industrial Control Equipment
UL 857	(1994) Busways and Associated Fittings
UL 1063	(1998) Machine-Tool Wires and Cables

1.2 SYSTEM DESCRIPTION

These specifications include the design, fabrication, assembly, wiring, installation and testing of the items of equipment and accessories and spare parts listed in the Schedule and shown on the drawings.

1.2.1 Rules

The equipment shall conform to the requirements of NFPA 70 unless more stringent requirements are indicated herein or shown. NEMA rated and UL listed equipment has been specified when available.

1.2.2 Coordination

The general arrangement of the medium voltage incoming section, motorized-fusible main switch and medium-voltage soft-start motor controllers is shown on the contract drawings and denoted as "Switchgear". Any modifications of the equipment arrangement or device requirements as shown on the drawings shall be subject to the approval of the Contracting Officer. If any conflicts occur necessitating departures from the drawings, details of and reasons for departures shall be submitted and approved prior to implementing any change. All equipment shall be completely assembled at the factory. The switchgear (motor controllers and mains) may be disassembled into sections, if necessary, for convenience of handling, shipping, and installation.

1.2.3 Seismic Qualifications

The switchgear and busway assembly (main switch and medium voltage solid state controller with busway connected considered as a single unit), when anchored per the manufacturer's recommendations and installation instructions, shall withstand specified horizontal and vertical accelerations without overturning or lateral movement. The manufacturer shall include in the submittals all the weights and securing features required for installation to these requirements. This equipment shall be designed for installation in a Seismic Hazard Exposure Group "II" Seismic Zone 3 with $A_v = 0.30$ and in accordance with Section 05900.

1.2.4 Standard Products

Material and equipment shall be product of a manufacturer regularly engaged in their manufacture and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. All materials shall conform to the requirements of these specifications. Materials shall be of high quality, free from defects and imperfections, of recent manufacture, and of the classification and

grades designated. All materials, supplies, and articles not manufactured by the Contractor shall be the products of other recognized reputable manufacturers.

1.2.5 Nameplates

Nameplates shall be made of laminated sheet plastic or of anodized aluminum approximately 4 millimeters (1/8 inch) thick, engraved to provide white letters on a black background. The nameplates shall be fastened to the panels in proper positions with anodized round-head screws. Lettering shall be minimum 15 millimeters (1/2 inch) high. Nameplate designations shall be in accordance with lists on the drawings, and as a minimum shall be provided for the following equipment:

- a. Motor Controllers
- b. Individual items of equipment mounted in the Motor Controllers
- c. Switchboards
- d. Main Switches
- f. Fuses
- g. Warning Signs for Multiple Electrical Services

Equipment of the withdrawal type shall be provided with nameplates mounted on the removable equipment in locations visible when the equipment is in place.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation. Equipment, materials, and articles installed or used without such approval shall be at the risk of subsequent rejection. Submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Equipment; GA.

The Contractor shall within 30 calendar days after date of award submit for approval six (6) copies of such descriptive cuts and information as are required to demonstrate fully that all parts of the equipment will conform to the requirements and intent of the specifications. Data shall include descriptive data showing typical construction of the types of equipment proposed, including the manufacturer's name, type of main fused switch, soft start motor starter, busway, performance capacities and other information pertaining to the equipment. Include motor/angle gear/pump speed-torque curve relationships from the respective mechanical submittals translated into inrush kVA requirements which the electrical system will require.

SD-04 Drawings

Outline Drawings; GA.

The Contractor shall, within 30 calendar days after date of award, submit for the approval of the Contracting Officer six (6) copies of outline drawings of all equipment to be furnished under this contract, together with weights and overall dimensions. Drawings shall show the general arrangement and overall dimensions of the incoming section and motor controllers. These drawings shall show space requirements, details of any floor supports to be embedded in concrete and provisions for conduits for external cables.

Incoming Section and Main Switch; GA.

The Contractor shall, within 30 calendar days after date of award submit for the approval of the Contracting Officer six (6) copies of the incoming section electrical equipment drawings. A single-line diagram, mechanical layout, electrical ratings, bussing diagram, busway connection flange and nameplate schedule shall be provided.

Motor Controller; GA.

The Contractor shall, within 30 calendar days after date of award, submit for the approval of the Contracting Officer six (6) copies of electrical equipment drawings. The motor controller drawings shall include a connection diagram with wire designations and schematic diagrams to illustrate operation of associated motor controller. An individual wiring diagram for each motor control center shall be submitted. Wiring diagrams shall be in a form showing physical arrangement of the controller with interconnecting wiring shown by lines. A single-line diagram, equipment list and nameplate schedule shall be provided for each motor controller.

Seismic Installation; GA.

The Contractor shall submit with equipment in this section the recommended anchoring points and capacities for seismic restraint as indicated in these specifications. Include equipment weights, center of gravity locations and acceleration forces to demonstrate the equipment supports meet requirements of Section 05900 SEISMIC PROTECTION FOR MECHANICAL, ELECTRICAL EQUIPMENT.

SD-08 Statements

Factory Tests; FIO.

The Contractor shall submit, within a minimum of 14 days prior to the proposed date of tests, six (6) copies of manufacturer's routine factory test procedures and production line tests for all motor controller and incoming sections.

SD-09 Reports

Factory Tests; FIO.

The Contractor shall submit six (6) complete reproducible copies of the factory inspection results and six (6) complete reproducible copies of the factory test results in booklet form, including all plotted data curves, all test conditions, a listing of test equipment complete with calibration certifications, and all measurements taken. Report shall be signed and dated by the Contractor's and Contracting Officer's Representatives.

Test Reports; GA

The Contractor shall submit six (6) complete reproducible copies of the field tests and inspection results and six (6) complete reproducible copies of the test results in booklet form, including all plotted data curves, all test conditions, a listing of test equipment complete with calibration certifications, and all measurements taken. Report shall be signed and dated by the Contractor's and Contracting Officer's Representatives

1.4 DELIVERY, STORAGE, AND HANDLING

The equipment shall be shipped as completely assembled and wired as feasible so as to require a minimum of installation work. Each shipping section shall be properly match marked to facilitate reassembly, and shall be provided with removable lifting channels with eye bolts for attachment of crane slings to facilitate lifting and handling. Any relay or other device which cannot withstand the hazards of shipment when mounted in place on the equipment shall be carefully packed and shipped separately. These devices shall be marked with the number of the panel which they are to be mounted on and fully identified. All finished painted surfaces and metal work shall be wrapped suitably or otherwise protected from damage during shipment. All parts shall be prepared for shipment so that slings for handling may be attached readily while the parts are in a railway car or transport truck. All spare parts and accessories shall be carefully packaged and clearly marked.

1.5 MAINTENANCE

1.5.1 Accessories and Tools

A complete set of accessories and special tools unique to equipment provided and required for erecting, handling, dismantling, testing and maintaining the apparatus shall be furnished by the Contractor. The Contractor shall furnish electrically insulating floor mats full length in front of all switchgear. The mats shall be 30 inches wide by the length of the housekeeping pad.

1.5.2 Spare Parts

Spare parts shall be furnished as recommended by the manufacturers and generally not less than that specified below. All spare parts shall be of the same material and workmanship, shall meet the same requirements, and shall be interchangeable with the corresponding original parts furnished.

- a. 3 - Fuses of each type and size.
- b. 1 - Operating coils for each size ac contactor.
- c. 1 - Complete sets of 3-pole stationary and moving contact assemblies for each size ac contactor.
- d. 1 - Contactor overload relays of each type and rating, each relay with a complete set of contact blocks.
- e. 1 - Spare set of heater elements for each heater rating provided.
- f. 2 - Indicating lamp assemblies of each type.
- g. 1 - Control transformer of each type and rating.
- h. 6 - Control relays of each type and rating.

- i. 6 - Contactor auxiliary contact of each type.
- j. 4 - One quart containers of finish paint for indoor equipment.
- k. 2 -One quart containers of the paint used for the exterior surfaces of outdoor equipment.
- l. 4 - Keys for motor controller and incoming section door lock.

PART 2 PRODUCTS

2.1 CONNECTIONS

The sizes and threads of all conduit and fittings, tubing and fittings, and connecting equipment shall be in accordance with English standard units. All ferrous fasteners shall have rust-resistant finish and all bolts and screws shall be equipped with approved locking devices. Manufacturer's standard threads and construction may be used on small items which, in the opinion of the Contracting Officer, are integrally replaceable, except that threads for external connections to these items shall meet the above requirements.

2.2 WIRING

All control wire shall be stranded tinned copper switchboard wire with 600-volt flame-retardant insulation Type SIS meeting UL 44 or Type MTW meeting UL 1063, and shall pass the VW-1 flame tests included in those standards. Hinge wire shall have Class K stranding. Current transformer secondary leads shall be not smaller than No. 10 AWG. The minimum size of control wire shall be No. 14 AWG. Power wiring for 480-volt circuits and below shall be of the same type as control wiring and the minimum size shall be No. 12 AWG. Special attention shall be given to wiring and terminal arrangement on the terminal blocks to permit the individual conductors of each external cable to be terminated on adjacent terminal points.

2.3 TERMINAL BLOCKS

Control circuit terminal blocks for control wiring shall be molded or fabricated type with barriers, rated not less than 600 volts. The terminals shall be removable binding, fillister or washer head screw type, or of the stud type with contact and locking nuts. The terminals shall be not less than No. 10 in size and shall have sufficient length and space for connecting at least two indented terminals for 10 AWG conductors to each terminal. The terminal arrangement shall be subject to the approval of the Contracting Officer and not less than four (4) spare terminals or 10 percent, whichever is greater, shall be provided on each block or group of blocks. Modular, pull apart, terminal blocks will be acceptable provided they are of the channel or rail-mounted type. The Contractor shall submit data showing that the proposed alternate will accommodate the specified number of wires, are of adequate current-carrying capacity, and are constructed to assure positive contact between current-carrying parts.

2.3.1 Types of Terminal Blocks

2.3.1.1 Short-Circuiting Type

Short-circuiting type terminal blocks shall be furnished for all current transformer secondary leads and shall have provision for shorting together all leads from each current transformer without first opening any circuit. Terminal blocks shall meet the requirements of paragraph TERMINAL BLOCKS above.

2.3.1.2 Load Type

Load terminal blocks rated not less than 600 volts and of adequate capacity shall be provided for the conductors for NEMA Size 3 and smaller motor controllers and for other power circuits except those for feeder tap units. The terminals shall be of either the stud type with contact nuts and locking nuts or of the removable screw type, having length and space for at least two indented terminals of the size required on the conductors to be terminated. For conductors rated more than 50 amperes, screws shall have hexagonal heads. Conducting parts between connected terminals shall have adequate contact surface and cross-section to operate without overheating. Each connected terminal shall have the circuit designation or wire number placed on or near the terminal in permanent contrasting color.

2.3.2 Marking Strips

White or other light-colored plastic marking strips, fastened by screws to each terminal block, shall be provided for wire designations. The wire numbers shall be made with permanent ink. The marking strips shall be reversible to permit marking both sides, or two marking strips shall be furnished with each block. Marking strips shall accommodate the two sets of wire numbers. Each device to which a connection is made shall be assigned a device designation in accordance with NEMA ICS 1 and each device terminal to which a connection is made shall be marked with a distinct terminal marking corresponding to the wire designation used on the Contractor's schematic and connection diagrams. The wire (terminal point) designations used on the Contractor's wiring diagrams and printed on terminal block marking strips may be according to the Contractor's standard practice; however, additional wire and cable designations for identification of remote (external) circuits shall be provided for the Government's wire designations. Prints of drawings submitted for approval will be so marked and returned to the Contractor for addition of the designations to the terminal strips and tracings, along with any rearrangement of points required.

2.4 BUSWAYS

Busses shall be copper. Enclosures shall be aluminum or stainless steel. Continuous and short-circuit ratings shall match the rating of the main switch specified herein, and shall be constructed in accordance with NEMA BU 1. The busway design shall be in accordance with IEEE C37.23 and NFPA 70 and UL 857. The busway shall connect directly to the incoming section main disconnect furnished in this specification. The Contractor shall coordinate the bus spacing of each component and furnish a complete and integrated power supply.

2.4.1 Feeder Busways

Feeder busways shall be ventilated, non-segregated phase type. Sandwiched or wafer style construction busway is not acceptable. The busway system shall include a 120 volt space heater system with thermostat and single point connection box. Provide electrical isolation between space heat low voltage connection to prevent voltage hazard or induced current effects in any system. The project facility will be idle for substantial periods of time and the intent is to prevent condensation during de-energized busway conditions by utilizing space heat with power derived from Service No. 2.

2.4.2 Busses

Busses shall be constructed of round edge copper bars. Copper contact surfaces shall be silver plated. Bus conductors shall be insulated with an extruded sleeve of track resistant, flame retardant,

nonhygroscopic, phenylene-oxide or liquid baked epoxy. Conductor joints shall be insulated with tape or flame retardant insulating boots.

Bus conductors shall be mounted and secured against short circuit forces in molded, track resistant, non-hygroscopic support blocks of glass reinforced polyester or high alumina ceramic material.

The bus conductors shall be completely enclosed in a grounded metal housing fabricated from aluminum or stainless steel.

2.4.3 Weatherhead

The busway shall exit the building as indicated on the drawings. The busway shall be provided with cable connection provision coordinated with the utility for material and size of conductor. The Contractor shall coordinate the exact size of the opening in the wall with approved shop drawings. The busway shall be furnished and installed with a weatherproof wall flange constructed of aluminum or stainless steel.

2.5 SPACE HEATERS

Space heaters shall be provided where indicated on the drawings and shall be controlled using an adjustable 10 to 35 degree C (50 to 90 degree F) thermostat, magnetic contactor, and a molded-case circuit breaker. The space heaters shall be 250-watt strip elements operated at 120 volts and shall be wired to terminal blocks for connection to 120-volt single-phase power sources located external to the control centers. The contactors shall be open type, electrically-held, rated 30 amperes, 2-pole, with 120-volt ac coils.

2.6 MOTOR OPERATED FUSED SWITCH

Air interrupter switches shall be group operated of the stored energy type, 3 pole single throw, utilizing a direct acting spring charged mechanism for both closing and opening functions. Switches shall be operable by electrical operator controlled from the front of the cubicle. The equipment shall be constructed in accordance with applicable portions of IEEE C37.20.2

2.6.1 Main Switch Ratings

System voltage:	5KV
Impulse withstand:	60KV
Momentary short circuit rating:	61,000 AIC
Main Bus Rating:	1200A Minimum
Nominal Voltage:	5kV, three-phase, 60Hz.
Voltage and Insulation Levels:	Conform to IEEE C37.20.2

Main Bus Ampacity: 1200 amperes continuous copper bus, minimum or as indicated on drawings.

Ground Bus: Copper, full length of switchgear.

2.6.2 Load Interrupter Switch

Provide quick-make, quick-break manual operating mechanism utilizing heavy duty, stored energy coil springs of rating matching the main bus rating.

Speed of opening and closing of the switch shall be independent of the operator. The switch blades cannot be teased to any intermediate positions. Provide separate main and spring loaded make and break arcing contacts.

Arc interruption shall take place only in the arc chutes which release de-ionizing gas to assist in extinguishing the arc. There shall be no arcing between the main blades and the stationery contacts.

Provide grounded metal safety barrier which shall prevent inadvertent contact with any live part, yet allow for a full view inspection of the switch blade position of all three phases.

Provide a gasketed tempered glass viewing window in the switch compartment door to allow visual inspection of the condition and position of the switch blades.

Safety Interlocking: Interlock switch and enclosure door so that: the door can be opened only when switch is in "OPEN" position. The switch operator shall be constructed so that switch cannot be closed unless the door is closed.

2.6.3 Accessories

Auxiliary Section for Motor Operated Switch
Draw out 5 KVA 1 Phase 4160-120/240V PT
PT Tiltout compartment w/ (2) -4200:120V Fused PT's
Fully rated 5KV CT's
Multilin PQM Microprocessor Meter or equal.

2.6.4 Metering

Multifunction meters shall be furnished and installed for the switchgear as indicated. The meter shall have dual RS-485 communications output ports with Modbus RTU protocol for data transmission to host computer device and a single RS-232 port on the front for laptop computer connection. The meter shall provide the following features:

- a. The meter shall be capable of displaying:
 - (1) Three phase voltages and amperes
 - (2) VA, Kilowatts, Kilovars
 - (3) Varhour, Watthours
 - (4) A, W, var, and VA demands
 - (4) Power Factor
 - (5) Frequency
 - (5) Harmonic analysis through the 63rd with THD and TIF
 - (6) VI unbalance
 - (7) True PF crest and K factor
- b. Voltage and current shall be sampled 64 times per cycle for 0.2% accuracy true RMS measured values.

- c. Actual values shall be displayed with illuminated 40 character LCD display and access by front panel keypad which can be used to program setpoints.
- d. Provide 3 output relays and 4 inputs which are user definable.
- e. The manufacturer shall integrate the control requirements and sequences indicated on the drawings.
- f. The meter manufacturer shall warrant the equipment for use in the ambient conditions that will be encountered. Provide all required appurtenances for reliable operation in non-conditioned ventilated spaces.
- g. Each meter and current transformer system shall be field tested as a unit in its final configuration and installed position by injecting simulated high current through the current transformers with a current test set. Contractor shall follow manufacturer's recommended test procedures.
- h. The meter shall be Multilin PQM Power Quality Meter or equal. The meter shall be mounted on the door of the low voltage compartment for easy access.

2.6.5 Power Fuses

Current limiting fuses positively held in position with provision for easy removal and replacement from front without the use of special tools. Fuse size shall meet fuse manufacturer's recommendation for the electrical load served.

Provide one set of spare refills for each fused switch shown. Mount in a holder on the inside of the fuse compartment door.

2.6.6 Surge Arrester

The medium voltage power system incoming section and motor controllers shall be protected by transient voltage surge suppressor suitable for application on the system supplied. The unit shall have peak surge current rating of 240,000 amperes per phase minimum. The unit shall have Maximum Continuous Operating Voltage rating of 5600 volts line-to-ground and 5800 volts line-to-line. The surge arrester shall be connected in accordance with the manufacturer's recommendations.

2.6.7 Fabrication

Each equipment bay shall be a separately constructed cubicle assembled to form a rigid free standing unit. Minimum sheet metal thickness shall be 11-gauge steel on all exterior surfaces. Adjacent bays shall be securely bolted together to form an integrated rigid structure. The unit shall be constructed for front access only with front alignment. To assist installation and maintenance of bus and cables, the rear covers shall be removable. Each individual unit shall be braced to prevent distortion. The construction shall conform to applicable portions of UL 50.

The metal enclosed switchgear shall be fully assembled, inspected and tested at the factory prior to shipment. Large line ups shall be split to permit normal shipping and handling as well as for ease of rejoining at the job site. Provide structure rigidity using steel member gussets in all corners of

structures. Furnish equipment not exceeding dimensions shown on the drawings. All steel members shall be painted.

All bolted power connections shall be torqued and marked in switchgear manufacturer's facility to recommended and published torque requirements. These marks shall be tested and verified in field testing.

2.6.8 Factory Finishing

All steel parts, except galvanized (if used) shall be cleaned and zinc phosphate pretreatment applied prior to paint application.

Provide powder coat paint process with color of ANSI 49 light gray, TGIC polyester powder, applied electrostatically through air.

2.7 MOTOR CONTROLLERS-SOFT START TYPE

The Contractor shall furnish and install solid state, soft-start motor controllers designed for operation on 4160Y/2400-volts ac, 3-phase, 60-Hz system, and the equipment shall conform to all the applicable requirements of NEMA ICS 1, NEMA ICS 2, NEMA ICS 3, NEMA ICS 4 and NEMA ICS 6. The controller shall start and run in continuous mode the pumps and angle gears drives furnished under this project. The starting characteristics of the pump, angle gear and motor acting together shall be coordinated utilizing motor, angle gear and pump submittal data, test data, coordination study results and utility company information to assure that successful starting and running of the motors is achieved by this installation.

Combination controller

Tin-plated copper horizontal power bus

A continuous bare copper ground bus

Power electronics

A main non-load break isolating switch and operating handle

A vacuum isolation contactor

A vacuum bypass contactor

Three (3) current limiting power fuses for NEMA Class E2 operation

Three (3) current transformers

A control power transformer

A low voltage control panel complete with micro-processor based control module

Space for necessary auxiliary control and metering devices

Top and bottom plates to accommodate entry cable connectors

Cooling fan(s) to provide cooling air flow as required for continuous and simultaneous operation of all three motors at rated horsepower in 104 Degrees F ambient in the environment shown on the drawings.

Structure and Controller: Each structure shall have two (2) non-removable base sill channels and removable lifting angles or brackets for ease of handling and installation.

The structure shall be divided into three (3) isolated compartments:

1. Main power and ground bus compartment
2. Power cell compartment
3. Low voltage compartment

Metal or plastic barriers shall be provided between each vertical section, between the low voltage compartment and the power cell and/or main power bus compartment and between the power cell and main power bus compartment. Personnel shall have access to the low voltage compartment, with the controller energized, without being exposed to any medium voltage.

The controller shall be of modular design to provide for ease and speed of maintenance. The modules are to be manufactured by one supplier designed to allow ease of maintenance, including removal of medium voltage components and power electronic components by maintenance personnel.

All components shall be mounted in a free standing NEMA Type 1 enclosure properly sized to dissipate the heat generated by the control within the limits of the specified environmental operating conditions.

2.7.1 Bypass Contactor

A bypass contactor shall be provided to short out the silicon controlled rectifiers (SCR)'s once the motor is up to full speed. When the stop function is selected, the bypass contactor will open bringing the SCR's back into the power circuit.

2.7.2 Structure Finish

As standard, all exterior and interior metal parts (except for the power cell back plates and low voltage panel) shall be painted ANSI 49 medium light gray. All metal back plates in the power cell and low voltage compartments shall be painted high gloss white for high visibility. Furnish field touch-up spray can(s), matching the enclosure color.

Description.....	Hybrid epoxy powder paint - high gloss.
Standard color	ANSI 49 medium light gray

2.7.3 Structure and Controller

Painting.....	Air-atomized electrostatic spray. Total paint thickness - 0.002" (0.051 mm) minimum
Baking.....	Natural gas oven at 355°F (179°C) minimum.

All unpainted steel parts shall be plated with a zinc plate/bronze chromate process for corrosion resistance.

2.7.4 Dimensions (400 AMP)

Structure depth shall be 36 inches, structure height shall be 91 inches . Combination controller width shall be 36 inches. Variance from these dimensions shall require the Contractor to layout his proposed changes for approval and at no additional cost to the Government and comply with NFPA 70 code clearances in Article 110.

2.7.5 Seismic Qualifications

The switchgear (main switch and medium voltage solid state controller and busway considered as a single unit), when anchored per the manufacturer's recommendations and installation instructions, shall withstand specified horizontal and vertical accelerations without overturning or lateral movement. The manufacturer shall include in the submittals all the weights and securing features required for installation to these requirements. This equipment shall be designed for installation in a Seismic Hazard Exposure Group "II" Seismic Zone 3 with $A_v = 0.30$ and in accordance with Section 05900 SEISMIC PROTECTION FOR MECHANICAL, ELECTRICAL EQUIPMENT.

Note: The seismic qualification does not, however, indicate that the medium voltage solid state equipment will operate properly during or after a seismic event; however, the internal components shall not damage themselves or adjacent internal equipment during a seismic event of the magnitude indicated. Similarly, the equipment enclosure shall be braced to withstand the event, without permanent deformation.

2.7.6 Interlocking

Provision shall be provided to mechanically interlock the doors of the power electronics and the isolation controller to prevent entry until power is removed and the isolating means is grounded.

2.7.7 Power Bus

The main horizontal power bus shall be located in the center, at the back of the structure, to provide optimum heat distribution, ease of maintenance and splicing. The power bus shall be mounted on edge to a molded bus support insulator in a common vertical plane. This shall provide better short circuit withstandability and protect against the accumulation of dust and tracking between phases. The power bus shall be made of tin plated copper and be furnished the following continuous current ratings: 1200 amps.

Access shall be provided to the bus compartment from the front or the rear of the structure to allow for installation and regular maintenance of the power and ground bus splice connections.

The horizontal buswork, the cabling/bus from the main power cell shall be braced and tested in accordance with NEMA ICS 3 and UL 347 (paragraph 30).

2.7.8 Bus Bracing

The horizontal/vertical buswork and the cabling/bus in the main power cell(s) shall be braced and tested in accordance with NEMA ICS 3 and UL 347.

The buswork and cabling shall be braced to withstand the let-through energy allowed by the largest fuse during a short circuit fault.

2.7.9 Ground Bus

A continuous copper ground bus shall be provided along the entire length of the controller line-up. A mechanical lug for #8-#4/0 AWG or #4-500 MCM cable shall be supplied at the incoming end of the line-up. The ground bus shall be sized as indicated on the drawings.

2.7.10 Technical Specifications

Nominal Ratings:	4200V
Power Ratings:	450% motor FLA for 30 seconds
Standard Insulation Test:	13.25 kV
Rated Short Circuit Amps:	50 kA RMS SYM
Maximum rated voltage	5.0 kV
Dielectric voltage withstand rating (insulation test) for 60 seconds:	5000V 18.2 kV
Basic Impulse Level (B.I.L.) rating	60 kV
Minimum insulation creepage to ground and between phases	8.9 cm (3.5 in.)
Minimum strike distance to ground and between phases	7.6 cm (3.0 in.)
Fault withstand MVA rating as a fused NEMA Class E2 controller:	at 4000V - 350 MVA symmetrical.
PIV Ratings: 4200V: 13000V	
Starting Torque:	0-90%
Ramp Time:	0-30 seconds
Acceleration Kick:	550% for 0.0 - 2.0 seconds
Quantity of Power Semi Conductors: (per phase)	4200V: 4
Lifting Provision Provided:	Yes
Removable	Yes
Control Module	Logic Design Feature

2.7.11 Mechanical

The control module shall be self-contained and compatible with the full range of power structures. The control module shall be easily removed from the controller, without the need to disassemble associated printed circuit boards.

Digital parameter adjustment shall be provided through a built-in keypad. Analog potentiometer adjustments are not acceptable. A built-in alphanumeric, backlit LCD display shall be provided for

controller set-up, diagnostics, status, and monitoring. The display shall be two-line, 16-characters minimum.

A serial communications port shall be provided as standard. Optional communications protocol interface modules shall be available for connection to Remote I/O, DH485, DeviceNet™, and RS-232/422/485.

2.7.12 Electrical

The control module shall provide digital microprocessor control and supervision of all controller operation, including SCR pulse firing control.

The SCR's shall be protected from voltage transients with an R-C snubber network.

The SCR's shall be protected from overvoltage with voltage threshold gating circuitry.

The SCR firing circuitry shall be fully isolated from the control circuits. Fiber optic cables shall be used for isolation from the logic circuits.

The logic provides one of the following sets of functions within a single controller:

- Soft Start with Selectable Kick-Start
- Current Limit
- Dual Ramp
- Full Voltage

Any one of the following options may be added to the MV Soft Start Controller standard functions listed above:

- Soft Stop
- Pump Control
- Preset Slow Speed

The acceleration ramp time shall be programmable from 0 to 30 seconds standard with longer times available if required by the coordination study.

The initial torque shall be programmable from 0% to 90% of locked rotor torque.

Kick-start, selectable with soft start or current limit function, shall provide an adjustable time pulse of current limit prior to the normal start mode. The current shall be held at 550% of the full load current for a time between 0.0 and 2.0 seconds. This feature shall be field selectable.

The controller shall provide the following monitoring functions indicated though the built-in LCD display:

- Phase-to-phase supply voltage
- Three-phase line current
- Watts in MW
- MWH
- Elapsed time
- Power factor
- Motor thermal capacity usage

Watts and watthours shall be capable of being measured in the bypass mode with the multifunction relay.

2.7.13 Protection and Diagnostics

The following protection shall be provided as standard with the controller:

- Power loss
- Line fault advising:
 - Shorted SCR
 - Missing load connection
- Line fault (running protection) advising:
 - Power loss
 - Shorted SCR
 - Missing load connection
- Phase reversal*
- Undervoltage*
- Overvoltage*
- Stall*
- Jam*
- Overload*
- Underload*
- Excessive starts/hour*
- Open gate
- Overtemperature

* These protective features shall be defeatable.

When these conditions are detected, starting of the controller shall be inhibited or the controller shall be shut down if it is operating. Contacts shall be furnished for external alarming of conditions “alarm” and “trip”. The “alarm” condition shall be a pre-trip condition alerting operating personnel of impending trip. The “trip” condition shall indicate sensing of a fault which has shutdown the pump. The multifunction relay shall display the condition and history of all “alarm” and “trip” conditions until reset manually.

Overload Protection

- Overload trip classes of 10, 15, 20, and 30 shall be provided and user-programmable
- Overload protection shall be available through the controller, even in a bypass configuration

2.7.14 Pump Control

The Pump Control option shall be implemented to provide closed loop control of a motor to match the specific torque requirements of centrifugal pumps for both starting and stopping. This shall aid in eliminating the phenomena commonly referred to as water hammer. Methods utilizing Soft Start with Soft Stop shall not be acceptable. Starting time shall be adjustable from 0 to 30 seconds, stopping shall be adjustable from 0 to 120 seconds.

2.7.14.1 Individual Control Transformers

Where 120 volt ac control of contactors and accessories are indicated or required, individual control transformer shall be provided on the load side of the unit disconnect. The control transformers shall be

rated 4160-120 volts and shall conform to the requirements for control transformers in NEMA ST 1. Control transformers shall have adequate volt-ampere capacity for the control functions indicated. Transformers shall be installed with primary fuses. Except as otherwise indicated on the drawings, each control transformer shall be provided with a fuse in one secondary lead and shall have the other secondary lead grounded.

2.7.14.2 Voltage Fault Protection

Controllers shall be provided with protection against voltage faults, phase unbalance, phase loss, phase reversal, undervoltage and overvoltage. Upon sensing one of these faults, the protector shall de-energize the starter. The protector shall use a combination of voltage and phase-angle sensing to detect phase loss even when regenerated voltages are present. The protector shall be connected to the load side of the motor circuit disconnect.

The protector shall have an adjustable line voltage trip level, adjustable trip delay, and be capable of being manually reset by front of doors means. An output contact for voltage fault alarm shall be provided.

Protector operation shall have repeatability of +1 percent of set point, maximum, and a dead band of 2 percent maximum. Protector shall have green indicator to show normal status and red indicator to show tripped status.

2.7.14.3 Control Circuit Disconnects

Control circuit power shall disconnect when the unit compartment is opened. Provide 120 VAC remote source for control power in the test mode. System shall positively prevent backfeed to primary side of control transformers.

2.7.15 Wiring for Motor Control Centers

All wiring shall meet the requirements of NEMA ICS 2. Heavy-duty terminals shall be provided by the Contractor for terminating all power cables entering the control centers.

2.7.15.1 Contractor's Wiring

The Contractor's wiring shall be formed into groups, suitably bound together, properly supported and run straight horizontally or vertically. There shall be no splices in the wiring. The manufacturer's standard pressure-type wire terminations for connections to internal devices will be acceptable. Terminal blocks shall be added for wiring to devices having leads instead of terminals. Spade tongue indented terminals shall be used on all wires terminated on control terminal blocks for external or interpanel connections and at shipping splits. All stud terminals shall have contact nuts and either locking nuts or lockwashers.

2.7.15.2 External Connections

Power and control cables will enter the control centers where shown on the drawings.

2.7.15.3 Terminal Blocks

Terminal blocks shall meet the requirements of NEMA ICS 4. In no case shall the terminals provided for controls or contactors accommodate less than the number or size of conductors shown on the

drawings. Special attention shall be given to wiring and terminal arrangement on the terminal blocks to permit the individual conductors of each external cable to be terminated on adjacent terminal points.

2.7.16 Accessories and Control Devices

Control accessories shall be provided, and shall be suitable for mounting on the front of, or inside, the controller as indicated on the drawings. Control accessories shall meet the applicable requirements of NEMA ICS 2. Relays and other equipment shall be so mounted that mechanical vibration will not cause false operation.

2.7.16.1 Control Stations

Push-button stations and selector switches shall conform to NEMA ICS 2, shall be of the heavy-duty, oil-tight type, rated 600 volts ac, and have a contact rating designation of A600. Switches shall be provided with escutcheon plates clearly marked to show operating positions.

2.7.16.2 LED Indicating Lights

Red and green LED's shall be furnished where shown on the drawings, indicating contact "open" and "closed" position. The LED's shall be accessible and replaceable from the front of the control center through a finished opening in the compartment door. The LED assemblies shall be of the heavy duty oiltight, watertight, and dusttight type. Provide push-to-test feature for all indicating lights.

2.7.16.3 Control Relays

Control relays shall be of the electrically operated, magnetically held, self-reset, open type, suitable for mounting inside the starter compartments, and shall be 120-volt ac. Contacts shall be as indicated on the drawings and shall have a contact rating designation of A600 or N600, as required, in accordance with NEMA ICS 2.

2.7.16.4 Timing Relays

Timers shall be electronic, with indication of timing and status of relay. They shall be suitable for mounting inside the control center and shall be rated 120 volts ac, 60 Hz. Instantaneous and time delay contacts shall be provided as indicated on the drawings, and shall have a contact rating designation of A600 or N600, as required, in accordance with NEMA ICS 2. Means shall be provided for manual adjustment over a range as indicated on the drawings.

2.7.16.5 Elapsed-Time Meters

Hour-indicating time meters shall have 6- digit registers with counter numbers at least 7 millimeters (1/4 inch) high. White numbers on black backgrounds shall provide hour indication with the last digit in contrasting colors to indicate tenths of an hour. The enclosure shall be 90 millimeters (3-1/2 inches) square and dust resistant. Operating voltage shall be 120 volts ac. They shall be of the nonreset type.

2.7.17 Metering Section

Metering section shall be provided with multifunction instruments as indicated on the drawings. Metering shall comply with IEEE C12.1.

2.7.18 Multifunction Protective Relays

Multifunction protective relays shall be furnished and installed for each pump controller indicated. Relays shall be multifunction electronic devices and installed as indicated on the drawings.

The relays shall have dual RS-485 communications output port with Modbus RTU protocol for data transmission to host computer device and a RS-232 port on front for laptop computer programming. The relays shall provide the following motor protective features:

- a. Motor Protection Module: The motor protection module shall provide motor management and protection features including the following:
 - (1) Phase overload standard curves (51)
 - (2) Phase overload by custom curve (51)
 - (3) I²T modeling (49)
 - (4) Stator Overtemperature/Bearing Overtemperature with 12 independent RTD inputs (49)
 - (5) Negative sequence unbalance/single phase (46)
 - (6) Phase reversal (47)
 - (7) Starts per hour and time between starts.(48)
 - (8) Short circuit (50)
 - (9) Ground Fault (50G/50N/51G/51N)
 - (10) Undercurrent (37)
- b. Management functions must include:
 - (1) Statistical Data
 - (2) Pre-Trip Data
 - (3) Ability to learn, display and integrate critical parameters
 - (4) Communication port to external devices
- c. The relay shall be capable of displaying:
 - (1) Phase voltage and amperes
 - (2) Kilowatts
 - (3) Kilovars
 - (4) Power Factor
 - (5) Frequency
 - (6) kWh's
- d. Actual Values displayed and access by keypad
 - (1) Three phase average current
 - (2) Individual phase current
 - (3) Hottest stator RTD temp
 - (4) Individual stator RTD temp
 - (5) Maximum stator RTD temp since last access
 - (6) Unbalance ratio
 - (7) Ground leakage current
 - (8) Individual motor bearing RTD temp
 - (9) Individual drive bearing RTD temp

- (10) Individual maximum bearing temp since last access
 - (11) Thermal capacity remaining/Estimated time to trip at present load
 - (12) Motor load in percent
 - (13) kW, kVAR, MWh, PF, Frequency
- e. The relay shall have both normally open and normally closed contacts from six output relays: R1 -TRIP, R2 -AUXILIARY, R3-AUXILIARY, R4-ALARM, R5-BLOCK START, R6-SERVICE.
- (1) The TRIP relay shall immediately trip the motor off if a fault is detected on any of the active protection features. The TRIP relay shall also separately initiate an alarm at the annunciator panel. The TRIP relay is a fail-safe relay (energized under normal operating conditions).
 - (2) The ALARM relay shall signal a remote alarm at the annunciator panel in the office. The ALARM relay is a non-fail-safe relay (de-energized under normal operating conditions). The ALARM relay is non-latching and will automatically reset.
 - (3) Remaining relays are reserved for future use.
- f. The manufacturer shall integrate the control requirements and sequences indicated on the drawings.
- g. The relay manufacturer shall warrant his equipment for use in the ambient conditions that will be encountered. Provide all required appurtenances for reliable operation in non-conditioned ventilated spaces.
- h. Each multifunction relay and current transformer system shall be field tested as a unit in its final configuration and installed position by injecting simulated high current through the CT's with a current test set. Contractor shall follow manufacturer's recommended test procedures.
- i. The multifunction relay shall be Multilin SR469 or equal. The meter shall be mounted on the door of the low voltage compartment with drawout case for easy access and removal.
- j. Provide one fully programmed spare multifunction relay installed and operated, fully tested, then removed and stored as directed by the Contracting Officer.

2.7.18.1 Instrument Transformers

All transformers used for metering shall meet the requirements of IEEE C12.11 and IEEE C57.13. Voltage transformers shall be protected with removable primary and secondary fuses. Fuses shall be installed in each ungrounded lead and located adjacent to the transformers in an easily accessible place. If cable connections to current transformer primary are required, terminals of an approved solderless type and proper size shall be furnished. If current transformers are connected to buses, proper connections shall be furnished, complete with bolts, nuts, washers and other accessories.

2.8 PAINTING

Interior and exterior steel surfaces of equipment enclosures shall be thoroughly cleaned and then receive a rust-inhibitive phosphatizing or equivalent treatment prior to painting. Exterior surfaces shall

be free from holes, seams, dents, weld marks, loose scale or other imperfections. Interior surfaces shall receive not less than one coat of corrosion-resisting paint in accordance with the manufacturer's standard practice. Exterior surfaces shall be primed, filled where necessary, and given not less than two coats baked enamel with semigloss finish. Equipment located indoors shall be ANSI 49 Light Gray. All touch-up work shall be done with manufacturer's coatings as supplied under paragraph SPARE PARTS.

2.9 FACTORY TESTS

Each item of equipment supplied under this contract shall be given the manufacturer's routine factory tests and tests as specified below, to insure successful operation of all parts of the assemblies. All tests required herein shall be witnessed by the Contracting Officer unless waived in writing, and no equipment shall be shipped until it has been approved for shipment by the Contracting Officer. The Contractor shall notify the Contracting Officer a minimum of 14 days prior to the proposed date of the tests so that arrangements can be made for the Contracting Officer to be present at the tests. The factory test equipment and the test methods used shall conform to the applicable NEMA Standards, and shall be subject to the approval of the Contracting Officer. Reports of all witnessed tests shall be signed by witnessing representatives of the Contractor and Contracting Officer. The cost of performing all tests shall be borne by the Contractor and shall be included in the prices bid.

2.9.1 Motor Controller Tests

2.9.1.1 Dielectric Tests

Each motor control center shall be completely assembled and given dielectric tests in accordance with NEMA ICS 1.

2.9.1.2 Quality Inspection

All incoming material shall be inspected and/or tested for conformance to quality assurance specifications.

All sub-assemblies shall be inspected and/or tested for conformance to vendor's engineering and quality assurance specifications.

All printed circuit boards with active components shall be burned-in for a minimum of 48 hours at 60°C.

The completed motor controller shall be functionally tested before shipment to assure proper operation per specification.

2.9.1.3 Operational Tests

The correctness of operation of each motor controller and of all control devices, accessories and indicating lamps, shall be checked. These checks shall be made at rated voltage with power supplies to the main buses.

PART 3 EXECUTION

3.1 FIELD TESTING

Field testing shall be performed in the presence of the Contracting Officer. The Contractor shall notify the Contracting Officer 10 days prior to conducting tests. The Contractor shall furnish all materials, labor, and equipment necessary to conduct field tests. The Contractor shall perform all tests and inspections recommended by the manufacturer unless specifically waived by the Contracting Officer. The Contractor shall maintain a written record of all tests which includes date, test performed, personnel involved, devices tested, serial number and name of test equipment, and test results. All field test reports will be signed and dated by the Contractor.

3.1.1 Safety

The Contractor shall provide and use safety devices such as rubber gloves, protective barriers, and danger signs to protect and warn personnel in the test vicinity. The Contractor shall replace any devices or equipment which are damaged due to improper test procedures or handling.

3.1.2 Cable Tests

The Contractor shall be responsible for identifying all equipment and devices that could be damaged by application of the test voltage and ensuring that they have been properly disconnected prior to performing insulation resistance testing. An insulation resistance test shall be performed on all low and medium voltage cables after the cables are installed in their final configuration and prior to energization. The test voltage shall be 500 volts DC applied for one minute between each conductor and ground and between all possible combinations of conductors. The minimum value of resistance shall be:

$$R \text{ in megohms} = (\text{rated voltage in kV} + 1) \times 1000 / (\text{length of cable in feet})$$

Each cable failing this test shall be repaired or replaced. The repaired cable system shall then be retested until failures have been eliminated.

3.1.2.1 Medium Voltage Cable Tests

- a. Continuity test.
- b. Insulation resistance test.
- c. DC high-potential test.

3.1.3 Low Voltage Cable Tests

- a. Continuity test.
- b. Insulation resistance test.

3.1.4 Metal Enclosed Bus Duct Tests

- a. Insulation Resistance phase-to-phase, all combinations.

- b. Insulation resistance phase-to-ground, each phase.
- c. AC or DC high-potential test.
- d. Phase rotation test.

3.1.5 Motor Tests

- a. Phase rotation test to ensure proper directions.
- b. Operation and sequence of reduced voltage starters.
- c. High potential test on each winding to ground.
- d. Insulation resistance of each winding to ground.
- e. Vibration test.
- f. Dielectric absorption test on motor and starter.

3.1.6 Circuit Breaker Tests

The following field tests shall be performed on circuit breakers.

3.1.6.1 Motor Starters

- a. Insulation resistance test phase-to-phase, all combinations. (In accordance with the manufacturers instruction).
- b. Insulation resistance test phase-to-ground, each phase.
- c. Closed breaker contact resistance test.
- d. Manual operation of the breaker.

3.1.7 Multifunction Relays

Multifunction relays shall be visually and mechanically inspected, adjusted, tested, and calibrated in accordance with the manufacturer's published instructions. These tests shall include pick-up, timing, contact action, restraint, and other aspects necessary to insure proper calibration and operation. Relay settings shall be implemented in accordance with the coordination study in Section 16475 COORDINATED POWER SYSTEM PROTECTION. Relay contacts shall be manually or electrically operated to verify that the proper breakers and alarms initiate. Relaying current transformers shall be field tested in accordance with IEEE C57.13.

3.2 OPERATING TESTS

After the installation is completed, and at such time as the Contracting Officer may direct, the Contractor shall conduct operating tests for approval. The equipment shall be demonstrated to operate

in accordance with the specified requirements. An operating test report shall be submitted in accordance with paragraph SUBMITTALS.

Test Forms are appended to this section and Section 16415 ELECTRICAL WORK, INTERIOR, APPENDIX 1 - MOTOR CERTIFICATION DATA. These forms shall be filled out for each individual motor, signed and submitted as specified.

Upon commissioning, the Contractor shall fill out the test forms. Upon starting the motor for the first time and repeating when water is available to pump, record the multifunction relay metering data, levels and other relevant data.

After each multifunction relay has been properly set and tested, the Contractor shall download the configuration of each relay to an electronic file. This may be accomplished with an IBM compatible personal computer and an RS-485/RS-232 protocol converter. The converter, download software, and connecting cables shall become the property of the Government. These configuration files shall be stored on 3.5" diskettes which are formatted using Excel compatible format. The Contractor shall affix type-written labels to each diskette with the filenames and associated pump names on the label. Six (6) duplicate copies of each diskette shall be submitted to the Contracting Officer.

3.3 FIELD SERVICE

3.3.1 On-site Training

The Contractor shall conduct a training course for the operating staff as designated by the Contracting Officer. The training period shall consist of a total of 16 hours of normal working time and shall start after the system is functionally completed but prior to final acceptance tests. The course instruction shall cover pertinent points involved in operating, starting, stopping, servicing the equipment, as well as all major elements of the operation and maintenance manuals. Additionally, the course instructions shall demonstrate all routine maintenance operations. A VHS format videotape of the entire training shall be submitted.

3.3.2 Installation Engineer

After delivery of the equipment, the Contractor shall furnish one or more field engineers, regularly employed by the equipment manufacturer to supervise the installation of equipment, assist in the performance of the on-site tests, oversee initial operations, and instruct personnel as to the operational and maintenance features of the equipment.

3.4 ACCEPTANCE

Final acceptance of the facility will not be given until the Contractor has successfully completed all tests and after all defects in installation, material or operation have been corrected.

3.4.1 Start-Up Service

The supplier of the motor controller described herein shall have a factory trained service representative in domestic residence within 150 miles (average) of the job site. The factory representative shall be trained in the maintenance and troubleshooting of the equipment as specified herein.

Start-up service is to be included for a period of not less than 35 hours, but in no case less than the time required to satisfactorily commission and operate the pump controllers.

3.4.2 Training

The Solid State Motor Controller manufacturer shall, as an option and at additional cost, quote separately an on-site or factory training program for plant personnel. This program shall provide operating and instruction manuals, training in equipment operation and troubleshooting of the controller.

3.4.3 Documentation

Six (6) Instruction Manuals, along with three (3) sets of schematic diagrams, shall be provided with the controller at time of shipment.

3.4.4 Spare Parts

Recommended spare parts list and prices shall be supplied with the equipment as listed and approved with shop drawings. Also, the address of the manufacturer's closest parts stocking location shall be provided.

End of Section

APPENDIX #1 TO SECTION 16405

MOTOR CERTIFICATION DATA

**US ARMY Corps of Engineers
New Madrid Pump Station**

MOTOR TEST REPORT

Each electric motor shall be tested for proper operation. Follow manufacturer's testing recommendations and procedures.

1. Name of Motor Tested
2. Visual Inspection Checklist
Motor Frame Bolts
Shaft Coupling
Lubricants
Other Comments:
3. Megger motor from wire in motor control center or control panel and record results.
 $\phi A - \phi B$ ____ $\phi B - \phi C$ ____ $\phi C - \phi A$
 $\phi A - G$ ____ $\phi B - G$ ____ $\phi C - G$
4. Momentarily bump motor shaft for proper rotation.

IF APPLICABLE, RECORD THE FOLLOWING INFORMATION.

5. Current Transformer Ratios
CT Phase A ____ CT Phase B ____ CT Phase C
6. Potential Transformer Ratios
Phase a-b ____ Phase b-c ____ Phase b-c

Comments:

Contractor's Authorized Representative (Signature
Required)

Date

Commissioning Summary

MOTOR NAME_____

**Page 1:SETPOINT VALUES
MOTOR AMPS SETPOINTS**

**Page 2:SETPOINT VALUES
RTD SETPOINTS**

**Page 3:SETPOINT VALUES
O/L CURVE SETPOINTS**

**Page 4:SETPOINT VALUES
RELAY CONFIGURATION**

Phase CT Secondary_____	Stator RTD's Used_____	Curve Number_____	O/L Trip
Phase CT Ratio_____	Stat 1 Alarm Level(°C)_____	Trip Time @ 1.05xFLC_____	U/B Trip
Motor FLC(amps)_____	RTD 1 Alarm Level(°C)_____	Trip Time @ 1.10_____	S/C Trip
O/L pickup Level(%)_____	Stat 1 Trip Level(°C)_____	Trip Time @ 1.20_____	Rapid Trip
Accel. Time(secs)_____	RTD 1 Trip Level (°C)_____	Trip Time @ 1.30_____	Stator RTD Trip
Starts/Hour_____	Stat 2 Alarm Level (°C)_____	Trip Time @ 1.40_____	RTD Trip
U/B Alarm Level (%)_____	RTD 2 Alarm Level (°C)_____	Trip Time @ 1.50_____	G/F Trip
U/B Alarm Delay (secs)_____	Stat 2 Trip Level (°C)_____	Trip Time @ 1.75_____	Accel. Time Trip
U/B Trip Level (%)_____	RTD 2 Trip Level (°C)_____	Trip Time @ 2.00_____	Phase Rev. Trip
U/B Trip Delay (secs)_____	Stat 3 Alarm Level (°C)_____	Trip Time @ 2.25_____	Inhibit Lockouts
G/F CT Secondary_____	RTD 3 Alarm Level (°C)_____	Trip Time @ 2.50_____	Speed Switch Trip
G/F CT Ratio_____	Stat 3 Trip Level (°C)_____	Trip Time @ 2.75_____	Differential Trip
G/F Alarm Level (amps)_____	RTD 3 Trip Level (°C)_____	Trip Time @ 3.00_____	Single Phase Trip
G/F Alarm Delay (secs)_____	Stat 4 Alarm Level (°C)_____	Trip Time @ 3.50_____	Spare Input Trip
G/F Trip Level (amps)_____	RTD 4 Alarm Level (°C)_____	Trip Time @ 4.00_____	U/V Trip
G/F Trip Delay (secs)_____	Stat 4 Trip Level (°C)_____	Trip Time @ 4.50_____	PF Trip
U/C Alarm Level (amps)_____	RTD 4 Trip Level (°C)_____	Trip Time @ 5.00_____	O/L Warning
U/C Alarm Delay (secs)_____	Stat 5 Alarm Level (°C)_____	Trip Time @ 5.50_____	G/F Alarm
Rapid Trip (x FLC)_____	RTD 5 Alarm Level (°C)_____	Trip Time @ 6.00_____	U/B Alarm
Rapid Trip Delay (secs)_____	Stat 5 Trip Level (°C)_____	Trip Time @ 6.50_____	U/C Alarm
S/C Trip Level (xFLC)_____	RTD 5 Trip Level (°C)_____	Trip Time @ 7.00_____	Stator RTD Alarm
S/C Trip Delay (secs)_____	Stat 6 Alarm Level (°C)_____	Trip Time @ 7.50_____	RTD Alarm
Immediate O/L (xFLC)_____	RTD 6 Alarm Level (°C)_____	Trip Time @ 8.00_____	No Sensor Alarm
	Stat 6 Trip Level (°C)_____		Self-Test Fail
	RTD 6 Trip Level (°C)_____		Spare Input Alarm
	RTD 7 Alarm Level (°C)_____		TC Alarm
	RTD 7 Trip Level (°C)_____		U/V Alarm
	RTD 8 Alarm Level (°C)_____		PF Alarm
	RTD 8 Trip Level (°C)_____		KVAR Alarm
	RTD 9 Alarm Level (°C)_____		MTM Alarm
	RTD 9 Trip Level (°C)_____		
	RTD 10 Alarm Level (°C)		
	RTD 10 Trip Level (°C)		
	RTD 11 Alarm Level (°C)		
	RTD 11 Trip Level (°C)		
	RTD 12 Alarm Level (°C)		
	RTD 12 Trip Level (°C)		

Contractor's Authorized Representative (Signature Required)

_____Date

**Page 5:SETPOINT VALUES
SYSTEM CONFIGURATION**

**Page 6:SETPOINT VALUES
SERVICE CODES**

**Page 7:SETPOINT VALUES
METERING SETPOINTS**

Norm Run Disp Line _____
Norm Run Disp Page _____
Defeat No Sensor Alarm _____
Defeat RTD Input _____
RTD Bias Curve Min (°C) _____
RTD Bias Center (%) _____
RTD Bias Center Temp (°C) _____
RTD Bias Curve Max (°C) _____
Defeat U/B Input _____
Defeat K Value _____
Defeat Learned Cool Time _____
Running Cool Time (min) _____
Stopped Cool Time (min) _____
RTD 10 Ambient Sensor _____
Defeat Speed Switch _____
Speed Switch Delay (sec) _____
Analog Output _____
Analog Output Type _____
Single Shot Restart _____
Start Inhibit _____
Special Ext Reset _____
Relay Alarm Latchcode _____
Drawout Failsafe Code _____
Relay Failsafe Code _____
Sp. Inp. Read 52B _____
Sp. Inp. Alarm Delay (sec) _____
Sp. Inp. Trip Delay (sec) _____
Backspin Timer Delay (min) _____
Time Between Starts (min) _____
FLC Therm Cap. Red. (%) _____
TC Used Alarm Level (%) _____
TC Used Alarm Delay (sec) _____
Slave Address _____

Applicable to Service
Application Only.

Setpoints Set/On Line?
MTM CT Primary (amps)
V.T. Ratio
U/V Alarm Level (%)
U/V Alarm Delay (sec)
U/V Trip Level (%)
U/V Trip Delay (sec)
PF Protection Delay (sec)
PF Lead Alarm Level
PF Lag Alarm Level
PF Alarm Delay (sec)
PF Lead Trip Level
PF Lag Trip Level
PF Trip Delay (sec)
KVAR Alarm Level
KVAR Alarm Delay
Voltage Phase Rev.?
Scale Factor

Contractor's Authorized Representative (Signature
Required)

Date

DIVISION 16 - ELECTRICAL

SECTION 16415

ELECTRICAL WORK, INTERIOR

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SECTION 16415

ELECTRICAL WORK, INTERIOR

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C39.1	(1981; R 1992) Requirements for Electrical Analog Indicating Instruments
ANSI C82.1	(1985; C82.1a; C82.1b; C82.1c; R 1992) Specifications for Fluorescent Lamp Ballasts
ANSI C82.4	(1992) Ballasts for High-Intensity-Discharge and Low-Pressure Sodium Lamps (Multiple-Supply Type)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B 1	(1995) Hard-Drawn Copper Wire
ASTM B 8	(1995) Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM D 709	(1997) Laminated Thermosetting Materials

CODE OF FEDERAL REGULATIONS (CFR)

47 CFR 18	Industrial, Scientific, and Medical Equipment
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INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41	(1991) Surge Voltages in Low-Voltage AC Power Circuits
IEEE/ANSI Std. C62.45	(1992) Guide on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits
IEEE Std 81	(1983) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System (Part 1)

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(1997) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA AB 1	(1997) Molded Case Circuit Breakers and Molded Case Switches
NEMA FU 1	(1986) Low Voltage Cartridge Fuses
NEMA ICS 1	(1993) Industrial Control and Systems
NEMA ICS 2	(1993) Industrial Control and Systems Controllers, Contactors, Overload Relays Rated Not More Than 2,000 Volts AC or 750 DC
NEMA ICS 3	(1993) Industrial Control and Systems Factory Built Assemblies
NEMA ICS 6	(1993) Industrial Control and Systems Enclosures
NEMA LE 4	(1987) Recessed Luminaries, Ceiling Compatibility
NEMA LS 1	(1992) Low Voltage Surge Protection Devices
NEMA MG 1	(1993; Rev 1; Rev 2; Rev 3) Motors and Generators
NEMA MG 10	(1994) Energy Management Guide for Selection and Use of Polyphase Motors
NEMA OS 1	(1996) Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports
NEMA PB 1	(1995) Panelboards
NEMA RN 1	(1989) Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
NEMA ST 20	(1992) Dry-Type Transformers for General Applications
NEMA WD 1	(1983; R 1989) General Requirements for Wiring Devices
NEMA WD 6	(1996) Wiring Devices - Dimensional Requirements

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(1999) National Electrical Code
NFPA 101	(1997) Safety to Life from Fire in Buildings and Structures

UNDERWRITERS LABORATORIES (UL)

UL-03	(1996; Supple) Electrical Construction Materials Directory
UL 1	(1993; Rev thru Jan 1995) Flexible Metal Conduit
UL 5	(1996) Surface Metal Raceways and Fittings
UL 6	(1997) Rigid Metal Conduit
UL 20	(1995; Rev thru Apr 1997) General-Use Snap Switches
UL 50	(1995; Rev Oct 1996) Enclosures for Electrical Equipment
UL 67	(1993; Rev thru Dec 1993) Panelboards
UL 83	(1998) Thermoplastic-Insulated Wires and Cables
UL 98	(1994; R Oct 1995) Enclosed and Dead-Front Switches
UL 198C	(1986; Rev thru Jun 1993) High-Interrupting-Capacity Fuses, Current-Limiting Types
UL 198E	(1988; Rev Jul 1988) Class R Fuses
UL 198G	(1988; Rev May 1988) Fuses for Supplementary Overcurrent Protection
UL 198L	(1995; Rev May 1995) D-C Fuses for Industrial Use
UL 360	(1996; Rev Mar 1997) Liquid-Tight Flexible Steel Conduit
UL 467	(1993; Rev thru Aug 1996) Grounding and Bonding Equipment
UL 486A	(1997) Wire Connectors and Soldering Lugs for Use with Copper Conductors
UL 486C	(1997) Splicing Wire Connectors
UL 486E	(1994; Rev thru Feb 1997) Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors
UL 489	(1996; Rev May 1997) Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures
UL 498	(1996) Attachment Plugs and Receptacles
UL 506	(1994; Rev Jul 1994) Specialty Transformers
UL 508	(1993) Industrial Control Equipment

UL 510	(1994) Insulating Tape
UL 512	(1993; R Dec 1995) Fuseholders
UL 514A	(1996) Metallic Outlet Boxes
UL 514B	(1997) Fittings for Conduit and Outlet Boxes
UL 514C	(1996) Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers
UL 542	(1994; Rev May 1997) Lampholders, Starters, and Starter Holders for Fluorescent Lamps
UL 797	(1993; Rev thru Mar 1997) Electrical Metallic Tubing
UL 817	(1994; Rev thru Feb 1997) Cord Sets and Power-Supply Cords
UL 845	(1995; Rev Feb 1996) Motor Control Centers
UL 924	(1995; Rev thru May 95) Emergency Lighting and Power Equipment
UL 935	(1995; Rev thru Apr 1997)Fluorescent-Lamp Ballasts
UL 943	(1993; Rev thru Mar 1997)Ground-Fault Circuit Interrupters
UL 1004	(1994; Rev thru Feb 1997) Electric Motors
UL 1029	(1994; Rev Sep 1995) High-Intensity-Discharge Lamp Ballasts
UL 1283	(1998) Electromagnetic Interference Filters
UL 1449	(1996) Transient Voltage Surge Suppressors (Second Edition)
UL 1570	(1995) Fluorescent Lighting Fixtures
UL 1571	(1995) Incandescent Lighting Fixtures
UL 1572	(1995; Rev thru Sep 96) High Intensity Discharge Lighting Fixtures
UL 1660	(1994) Liquid-Tight Flexible Nonmetallic Conduit

1.2 GENERAL

1.2.1 Rules

The installation shall conform to the requirements of NFPA 70 and NFPA 101, unless more stringent requirements are indicated herein or shown.

1.2.2 Coordination

The drawings indicate the extent and the general location and arrangement of equipment, conduit, and wiring. The Contractor shall become familiar with all details of the work and verify all dimensions in the field so that the outlets and equipment shall be properly located and readily accessible. Lighting fixtures, outlets, and other equipment and materials shall be located to avoid interference with mechanical or structural features; otherwise, lighting fixtures shall be symmetrically located according to the room arrangement when uniform illumination is required, or asymmetrically located to suit conditions fixed by design and shown. Raceways, junction and outlet boxes, and lighting fixtures shall not be supported from sheet metal roof decks. If any conflicts occur necessitating departures from the drawings, details of and reasons for departures shall be submitted and approved prior to implementing any change. The Contractor shall coordinate electrical work with the HVAC and electrical drawings and specifications and provide power related wiring.

1.2.3 Special Environments

1.2.3.1 Weatherproof Locations

Wiring, fixtures, and equipment in designated locations shall conform to NFPA 70 requirements for installation in damp or wet locations.

1.2.3.2 Hazardous Locations

No locations are classified as hazardous locations as defined by NFPA 70.

1.2.3.3 Ducts, Plenums and Other Air-Handling Spaces

Wiring and equipment in ducts, plenums and other air-handling spaces shall be installed using materials and methods in conformance with NFPA 70 unless more stringent requirements are indicated in this specification or on the contract drawings.

1.2.4 Standard Products

Material and equipment shall be a standard product of a manufacturer regularly engaged in the manufacture of the product and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening.

1.2.5 Nameplates

1.2.5.1 Identification Nameplates

Major items of electrical equipment and major components shall be permanently marked with an identification name to identify the equipment by type or function and specific unit number as indicated. Designation of motors shall coincide with their designation in the motor control center or panel.

Unless otherwise specified, identification nameplates shall be made of laminated plastic in accordance with ASTM D 709 with black outer layers and a white core. Edges shall be chamfered. Plates shall be fastened with black-finished round-head drive screws, except motors, or approved nonadhesive metal fasteners. When the nameplate is to be installed on an irregular-shaped object, the Contractor shall devise an approved support suitable for the application and ensure the proper installation of the supports and nameplates. In all instances, the nameplate shall be installed in a conspicuous location. At the option of the Contractor, the equipment manufacturer's standard embossed nameplate material with black paint-filled letters may be furnished in lieu of laminated plastic. The front of each panelboard, motor control center, switchgear, and switchboard shall have a nameplate to indicate the phase letter, corresponding color and arrangement of the phase conductors. The following equipment, as a minimum, shall be provided with identification nameplates:

Minimum 1/4 inch
High Letters

Panelboards
Starters
Safety Switches
Motor Control Centers
Transformers
Equipment Enclosures
Switchgear
Switchboards
Motors

Minimum 1/8 inch
High Letters

Control Power Transformers
Control Devices
Instrument Transformers

Each panel, section, or unit in motor control centers, switchgear or similar assemblies shall be provided with a nameplate in addition to nameplates listed above, which shall be provided for individual compartments in the respective assembly, including nameplates which identify "future," "spare," and "dedicated" or "equipped spaces."

1.2.6 As-Built Drawings

Following the project completion or turnover, within 30 days the Contractor shall furnish two sets of as-built drawings to the Contracting Officer.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Manufacturer's Catalog; FIO.

Data composed of catalog cuts, brochures, circulars, specifications, product data, and printed information in sufficient detail and scope to verify compliance with the requirements of the contract documents.

Material, Equipment, and Fixture Lists; GA.

A complete itemized listing of equipment and materials proposed for incorporation into the work. Each entry shall include an item number, the quantity of items proposed, and the name of the manufacturer of each item.

Installation Procedures; FIO.

Installation procedures for rotating equipment, transformers, switchgear, battery systems, voltage regulators, and grounding resistors. Procedures shall include diagrams, instructions, and precautions required to install, adjust, calibrate, and test devices and equipment.

A certification that contains the names and the qualifications of people recommended to perform the splicing and termination of medium-voltage cables approved for installation under this contract. The certification shall indicate that any person recommended to perform actual splicing and terminations has been adequately trained in the proper techniques and have had at least three recent years of experience in splicing and terminating the same or similar types of cables approved for installation. In addition, any person recommended by the Contractor shall be required to perform a practice splice and termination, in the presence of the Contracting Officer, before being approved as a qualified installer of medium-voltage cables. The Contractor shall provide short sections of the approved types of cables along with the approved type of splice and termination kits, and detailed manufacturer's instruction for the proper splicing and termination of the approved cable types.

The Contractor shall provide at least one onsite person in a supervisory position with a documentable level of competency and experience, with a second equally capable person on permanent staff. as backup.

Submittals for cable and termination products are required. The submittal shall include manufacturer data including dimensions, technical specifications, installation procedures, and similar data to allow assurance that the specifications of this section are met.

SD-04 Drawings

Interior Electrical Equipment; GA.

Detail drawings consisting of equipment drawings, illustrations, schedules, instructions, diagrams, and other information necessary to define the installation. Detail drawings shall show the rating of items and systems and how the components of an item and system are assembled, function together, and how they will be installed on the project. Data and drawings for component parts of an item or system shall be coordinated and submitted as a unit. Data and drawings shall be coordinated and included in a single submission. Multiple submissions for the same equipment or system are not acceptable except where prior approval has been obtained from the Contracting Officer. In such cases, a list of data to be submitted later shall be included with the first submission. Detail drawings shall show physical arrangement, construction details, connections, finishes, materials used in fabrication, provisions for conduit or busway entrance, access requirements for installation and maintenance, physical size, electrical characteristics, foundation and support details, and equipment weight. Drawings shall be drawn to scale and/or dimensioned. Optional items shall be clearly identified as included or excluded. Detail drawings shall as a minimum include:

- a. Transformers.
- b. Panelboards.
- c. Receptacle mounting.

- d. Supports for electrical equipment.
- e. Single line electrical diagrams including primary, metering, sensing and relaying, control wiring, and control logic.
- f. Sway bracing for suspended luminaires.

Structural drawings showing the structural or physical features of major equipment items, components, assemblies, and structures, including foundations or other types of supports for equipment and conductors. These drawings shall include accurately scaled or dimensioned outline and arrangement or layout drawings to show the physical size of equipment and components and the relative arrangement and physical connection of related components. Weights of equipment, components and assemblies shall be provided when required to verify the adequacy of design and proposed construction of foundations or other types of supports. Dynamic forces shall be stated for switching devices when such forces must be considered in the design of support structures. The appropriate detail drawings shall show the provisions for leveling, anchoring, and connecting all items during installation, and shall include any recommendations made by the manufacturer.

Electrical drawings including single-line and three-line diagrams, and schematics or elementary diagrams of each electrical system; internal wiring and field connection diagrams of each electrical device when published by the manufacturer; wiring diagrams of cabinets, panels, units, or separate mountings; interconnection diagrams that show the wiring between separate components of assemblies; field connection diagrams that show the termination of wiring routed between separate items of equipment; internal wiring diagrams of equipment showing wiring as actually provided for this project. Field wiring connections shall be clearly identified.

If departures from the contract drawings are deemed necessary by the Contractor, complete details of such departures, including changes in related portions of the project and the reasons why, shall be submitted with the detail drawings. Approved departures shall be made at no additional cost to the Government.

As-Built Drawings; GA.

The as-built drawings shall be a record of the construction as installed. The drawings shall include all the information shown on the contract drawings, deviations, modifications, and changes from the contract drawings, however minor. The as-built drawings shall be kept at the job site and updated daily. The as-built drawings shall be a full-sized set of prints marked to reflect all deviations, changes, and modifications. The as-built drawings shall be complete and show the location, size, dimensions, part identification, and other information. Additional sheets may be added. The as-built drawings shall be jointly inspected for accuracy and completeness by the Contractor's quality control representative and by the Contracting Officer prior to the submission of each monthly pay estimate. Upon completion of the work, the Contractor shall submit three full sized sets of the marked prints to the Contracting Officer for approval. If upon review, the as-built drawings are found to contain errors and/or omissions, they will be returned to the Contractor for correction. The Contractor shall correct and return the as-built drawings to the Contracting Officer for approval within ten calendar days from the time the drawings are returned to the Contractor.

SD-08 Statements

On-Site Test; GA.

A detailed description of the Contractor's proposed procedures for on-site tests.

SD-09 Reports

Factory Test Reports; GA.

Six copies of the information described below in 8 1/2 x 11 inch binders having a minimum of 5 rings from which material may readily be removed and replaced, including a separate section for each test. Sections shall be separated by heavy plastic dividers with tabs.

- a. A list of equipment used, with calibration certifications.
- b. A copy of measurements taken.
- c. The dates of testing.
- d. The equipment and values to be verified.
- e. The conditions specified for the test.
- f. The test results, signed and dated.
- g. A description of adjustments made.

Field Test Plan; GA.

A detailed description of the Contractor's proposed procedures for on-site test submitted 20 days prior to testing the installed system. No field test will be performed until the test plan is approved. The test plan shall consist of complete field test procedures including tests to be performed, test equipment required, and tolerance limits.

Field Test Reports; GA.

Six copies of the information described below in 8 1/2 x 11 inch binders having a minimum of 5 rings from which material may readily be removed and replaced, including a separate section for each test. Sections shall be separated by heavy plastic dividers with tabs.

- a. A list of equipment used, with calibration certifications.
- b. A copy of measurements taken.
- c. The dates of testing.
- d. The equipment and values to be verified.
- e. The conditions specified for the test.
- f. The test results, signed and dated.
- g. A description of adjustments made.

- h. Final position of controls and device settings.

SD-13 Certificates

Materials and Equipment; GA.

The label or listing of the Underwriters Laboratories, Inc., will be accepted as evidence that the materials or equipment conform to the applicable standards of that agency. In lieu of this label or listing, a statement from a nationally recognized, adequately equipped testing agency indicating that the items have been tested in accordance with required procedures and that the materials and equipment comply with all contract requirements will be accepted. However, materials and equipment installed in hazardous locations must bear the UL label unless the data submitted from other testing agency is specifically approved in writing by the Contracting Officer. Items which are required to be listed and labeled in accordance with Underwriters Laboratories must be affixed with a UL label that states that it is UL listed. No exceptions or waivers will be granted to this requirement. Materials and equipment will be approved based on the manufacturer's published data.

For other than equipment and materials specified to conform to UL publications, a manufacturer's statement indicating complete compliance with the applicable standard of the American Society for Testing and Materials, National Electrical Manufacturers Association, or other commercial standard, is acceptable.

1.4 WORKMANSHIP

Materials and equipment shall be installed in accordance with NFPA 70, recommendations of the manufacturer, and as shown.

PART 2 PRODUCTS

Products shall conform to the respective publications and other requirements specified below. Materials and equipment not listed below shall be as specified elsewhere in this section. Items of the same classification shall be identical including equipment, assemblies, parts, and components.

2.1 CABLES AND WIRES

Conductors No. 8 AWG and larger diameter shall be stranded. Conductors No. 10 AWG and smaller diameter shall be solid, except that conductors for remote control, alarm, and signal circuits, classes 1, 2, and 3, shall be stranded unless specifically indicated otherwise. Conductor sizes and ampacities shown are based on copper, unless indicated otherwise. All conductors shall be copper.

2.1.1 Equipment Manufacturer Requirements

When manufacturer's equipment requires copper conductors at the terminations or requires copper conductors to be provided between components of equipment, provide copper conductors or splices, splice boxes, and other work required to meet manufacturer's requirements.

2.1.2 Insulation

Unless indicated otherwise, or required by NFPA 70, power and lighting wires shall be 600-volt, Type THWN or THHN conforming to UL 83; remote-control and signal circuits shall be Type THW or TF,

conforming to UL 83. Where lighting fixtures require 90-degree Centigrade (C) conductors, provide only conductors with 90-degree C insulation or better.

2.1.3 Bonding Conductors

ASTM B 1, solid bare copper wire for sizes No. 8 AWG and smaller diameter; ASTM B 8, Class B, stranded bare copper wire for sizes No. 6 AWG and larger diameter.

2.1.4 Tray Cable or Power Limited Tray Cable

UL listed; Type TC or PLTC.

2.1.5 Cord Sets and Power-Supply Cords

UL 817.

2.2 TRANSIENT VOLTAGE SURGE PROTECTION

Transient voltage surge suppressors shall be provided as indicated. Surge suppressors shall meet the requirements of IEEE C62.41 and be UL listed and labeled as having been tested in accordance with UL 1449. Surge suppressor ratings shall be as indicated in table volts rms, operating voltage; 60 Hz; 3-phase; 4 wire with ground; transient suppression voltage (peak let-through voltage) of 800 volts. Fuses shall not be used as surge suppression.

2.2.1 General

- a. This section describes all transient voltage surge suppression equipment for protecting certain electrical services, motor control centers, and panelboards as indicated in the drawings.
- b. The work includes the installation, connection, and testing of new surge arresters as complete, fully functional surge suppression systems as indicated in the drawings.
- c. Types of surge arresters specified in this section include the following:
 - (1) Surge Arresters for Power Panelboards
 - (2) Surge Arresters for Lighting/Appliance Panelboards

2.2.2 Quality Assurance

- a. Manufacturers: Firms regularly engaged in manufacture of surge arresters, of types, sizes and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.
- b. Installer's Qualifications: Firm with at least 5 years of successful installation experience on projects utilizing surge arresters similar to those required for this project.
- c. NEC Compliance: Comply with NEC as applicable to wiring methods, construction and installation of surge arresters with specific attention to Article 280 Surge Arresters. .

- d. UL Compliance: Comply with applicable requirements of UL 1449 and UL 1283 pertaining to surge arresters. Provide surge arresters and components which are UL-listed and labeled.
- e. IEEE/ANSI Compliance: Comply with applicable requirements of IEEE/ANSI Std. C62.41-1991, "Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits," and C62.45-1992, "Guide on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits," pertaining to surge arresters.
- f. NEMA Compliance: Comply with applicable requirements of NEMA LS 1 pertaining to surge arresters.
- g. Each type of surge arrester shall be of a single manufacturer.

2.2.3 Surge Arrester-High Exposure

- a. High Exposure Level Protection: Provide a TVSS on each Motor Control Center as shown in the plans. Provide a TVSS of adequate size and type for electric service entrance protection. The TVSS shall be UL 1449 (Second Edition) listed, have a remote fused disconnect, have a display event counter, have pilot lights for each phase indicating trouble conditions, and have dry contacts to indicate alarm status. The TVSS shall have the following characteristics:

Application	277/480 V rms, 3 Phase, Wye, 4 Wire + Ground
Enclosure	NEMA 1
Wire	#2 AWG minimum, minimum lead length.
Maximum Continuous Operating Voltage (MCOV)	320 V rms Line-Neutral 640 V rms Line-Line
Input Power Frequency	60 Hz
Peak Surge Current	250,000A per normal mode, 250,000A per common mode, (8x20 μ s waveform, single impulse)
Life Cycle Test	7,000 Hits Minimum at CAT. C3, 20kV, 10kA, without failing or degrading the UL 1449 rating more than 10%
EMI/RFI Filter	Equipped, UL 1283 Listed
Protection Modes	Normal Mode (Line-Line, Line-Neutral) Common Mode (Line-Ground, Neutral-Ground) All Modes shall be protected. Bi-directional, Positive and Negative Impulses
Let-Through Voltage	CAT C1-Impulse, 6,000V, 3,000A: 850 Vpk (Line-Neutral) CAT C3-Impulse, 20,000V, 10,000A: 1,100 Vpk (Line-Neutral)
UL 1449 Suppression Voltage Level	900 V, Line-Neutral, CAT C1

2.2.4 Surge Arrester-Medium Exposure

- a. Medium Exposure Level Protection: Provide a TVSS on each panelboard as shown in the plans. Provide a TVSS of adequate size and type for electric service entrance protection. The TVSS shall be UL 1449 (Second Edition) listed, have a display event counter, have pilot lights for each phase indicating trouble conditions, and have dry contacts to indicate alarm status. The TVSS shall have an integral fused disconnect or shall be connected to a circuit breaker in the distribution center or panelboard as shown in the plans. The TVSS shall have the following characteristics:

Application	277/480 V rms, 3 Phase, Wye, 4 Wire + Ground
Enclosure	NEMA 1
Wire	#2 AWG minimum, minimum lead length.
Maximum Continuous Operating Voltage (MCOV)	320 V rms Line-Neutral 640 V rms Line-Line
Input Power Frequency	60 Hz
Peak Surge Current	150,000A per mode, (8x20 μ s waveform, single impulse)
Life Cycle Test	5,500 Hits Minimum at CAT. C3, 20kV, 10kA, without failing or degrading the UL 1449 rating more than 10%
EMI/RFI Filter	Equipped, UL 1283 Listed
Protection Modes	Normal Mode (Line-Line, Line-Neutral) Common Mode (Line-Ground, Neutral-Ground) All modes protection. Bi-directional, Positive and Negative Impulses
Let-Through Voltage	CAT C1-Impulse, 6,000V, 3,000A: 850 Vpk (Line-Neutral) CAT C3-Impulse, 20,000V, 10,000A: 1150 Vpk (Line-Neutral)
UL 1449 Suppression Voltage Level	900 V, Line-Neutral, CAT C1

2.2.5 Surge Arrester-Low Exposure

- a. Low Exposure Level Protection: Provide a TVSS on each panelboard as shown in the plans. Provide a TVSS of adequate size and type for electric service entrance protection. The TVSS shall be UL 1449 (Second Edition) listed, have pilot lights indicating operational/trouble conditions, and have dry contacts to indicate alarm status. The TVSS shall have an integral fused disconnect, fuse block, or shall be connected to a circuit breaker in the distribution center or panelboard as shown in the plans. The TVSS shall have the following characteristics:

Application	120/208 V rms, 3 Phase, Wye, 4 Wire + Ground
Enclosure	NEMA 1
Wire	#4 AWG Minimum

Max operating voltage	150 V rms Line-Neutral 275 V rms Line-Line
Input Power Frequency	60 Hz
Peak Surge Current	80,000 Amperes Per Phase, (8x20 μ s Waveform, Single Impulse)
Life Cycle Test	4,000 Hits Minimum at CAT. C3, 20kV, 10kA
EMI/RFI Filter	Equipped, UL 1283 Listed
Protection	Normal Mode (Line-Line, Line-Neutral) Common Mode (Line-Ground, Neutral-Ground) All modes protected. Bi-directional Positive & Negative Impulses
Let-Through Voltage	CAT C1-Impulse, 6,000V, 3,000A: 425 Vpk Maximum (Line-Neutral) CAT C3-Impulse, 20,000V, 10,000A: 550 Vpk Maximum (Line-Neutral)
UL 1449 Suppression Voltage Level	500 Volts Maximum, Line-Neutral, Test Category C1

2.3 CIRCUIT BREAKERS

2.3.1 Molded-Case Circuit Breakers

Molded-case circuit breakers shall conform to NEMA AB 1 and UL 489. Circuit breakers may be installed in panelboards only.

2.3.1.1 Construction

Circuit breakers shall be suitable for mounting and operating in any position. Lug shall be listed for copper and aluminum conductors in accordance with UL 486E. Single-pole circuit breakers shall be full module size with not more than one pole per module. Multi-pole circuit breakers shall be of the common-trip type having a single operating handle such that an overload or short circuit on any one pole will result in all poles opening simultaneously. Sizes of 100 amperes or less may consist of single-pole breakers permanently factory assembled into a multi-pole unit having an internal, mechanical, nontamperable common-trip mechanism and external handle ties. All circuit breakers shall have a quick-make, quick-break overcenter toggle-type mechanism, and the handle mechanism shall be trip-free to prevent holding the contacts closed against a short-circuit or sustained overload. All circuit breaker handles shall assume a position between "ON" and "OFF" when tripped automatically. All ratings shall be clearly visible.

2.3.1.2 Ratings

Voltage ratings shall be not less than the applicable circuit voltage. The interrupting rating of the circuit breakers shall be at least equal to the available short-circuit current at the line terminals of the circuit breaker and correspond to the UL listed integrated short-circuit current rating specified for the panelboards. Molded-case circuit breakers shall have nominal voltage ratings, maximum continuous-current ratings, and maximum short-circuit interrupting ratings in accordance with NEMA AB 1. Ratings shall be coordinated with system X/R ratio.

2.3.1.3 Thermal-Magnetic Trip Elements

Thermal magnetic circuit breakers shall be provided as shown. Automatic operation shall be obtained by means of thermal-magnetic tripping devices located in each pole providing inverse time delay and instantaneous circuit protection. The instantaneous magnetic trip shall be adjustable and accessible from the front of all circuit breakers on frame sizes above 150 amperes.

2.3.2 SWD Circuit Breakers

Circuit breakers rated 15 amperes and intended to switch 277 volts or less fluorescent lighting loads shall be marked "SWD."

2.3.3 HACR Circuit Breakers

Circuit breakers 60 amperes or below, 240 volts, 1-pole or 2-pole, intended to protect multi-motor and combination-load installations involved in heating, air conditioning, and refrigerating equipment shall be marked "Listed HACR Type."

2.3.4 Ground Fault Circuit Interrupters

UL 943. Breakers equipped with ground fault circuit interrupters shall have ground fault class, interrupting capacity, and voltage and current ratings as indicated.

2.4 CONDUIT AND TUBING

2.4.1 Electrical, Zinc-Coated Steel Metallic Tubing (EMT)

UL 797

2.4.2 Flexible Conduit, Steel and Plastic

General-purpose type, UL 1; liquid tight, UL 360, and UL 1660.

2.4.3 PVC Coated Rigid Steel Conduit

NEMA RN 1.

2.4.4 Rigid Metal Conduit

UL 6.

2.4.5 Surface Metal Electrical Raceways and Fittings

UL 5.

2.5 CONDUIT AND DEVICE BOXES AND FITTINGS

2.5.1 Boxes, Metallic Outlet

NEMA OS 1 and UL 514C.

2.5.2 Boxes, Switch (Enclosed), Surface-Mounted

UL 98.

2.5.3 Fittings for Conduit and Outlet Boxes

UL 514B.

2.6 CONDUIT COATINGS PLASTIC RESIN SYSTEM

NEMA RN 1, Type A-40.

2.7 CONNECTORS, WIRE PRESSURE

2.7.1 For Use With Copper Conductors

UL 486A.

2.8 ELECTRICAL GROUNDING AND BONDING EQUIPMENT

UL 467.

2.8.1 Ground Rods

Ground rods shall be of copper-clad steel conforming to UL 467 not less than 3/4 inch in diameter by 10 feet in length of the sectional type driven full length into the earth.

2.8.2 Ground Bus

The ground bus shall be bare conductor or flat copper in one piece, if practicable.

2.9 ENCLOSURES

NEMA ICS 6 or NEMA 250 unless otherwise specified.

2.9.1 Cabinets and Boxes

Cabinets and boxes with volume greater than 100 cubic inches shall be in accordance with UL 50, hot-dip, zinc-coated, if sheet steel.

2.9.2 Circuit Breaker Enclosures

UL 489.

2.10 FIXTURES, LIGHTING AND FIXTURE ACCESSORIES/COMPONENTS

Standard Drawing 40-06-04 sheets referenced hereinafter and enclosed as an integral part of these specifications and additional fixtures shown on contract drawings. Fixtures, accessories and components, including ballasts, lampholders, lamps, starters and starter holders, shall conform to industry standards specified below.

2.10.1 Fixture, Auxiliary or Emergency

UL 924.

2.10.2 Incandescent Fixture

NEMA LE 4 for ceiling compatibility of recessed fixtures and UL 1571.

2.10.3 Fluorescent

- a. Fixture: NEMA LE 4 for ceiling compatibility of recessed fixtures and UL 1570. Fixtures shall be plainly marked for proper lamp and ballast type to identify lamp diameter, wattage, color and start type. Marking shall be readily visible to service personnel, but not visible from normal viewing angles.
- b. Ballasts:
 - (1) Magnetic ballast, energy-saving, high power factor, Class P, automatic-resetting Type, approved for the application by the Certified Ballast Manufacturers: ANSI C82.1 and UL 935. Two-lamp ballasts shall be used for each pair of lamps within a fixture or within continuous mounted fixtures. Single-lamp ballasts shall be used for individually mounted single-lamp fixtures and where an odd single-lamp fixture occurs at the end of a continuous group. Magnetic fluorescent lamp ballasts shall have a Ballast Efficacy Factor (BEF) not less than shown in the following table:
 - (2) Electronic Ballast. Electronic ballasts shall consist of a rectifier, high frequency inverter, and power control and regulation circuitry. The ballasts shall be UL listed, Class P, with a Class A sound rating and shall contain no PCBs. Ballasts shall meet 47 CFR 18 for electromagnetic interference and shall not interfere with the operation of other electrical equipment. Design shall withstand line transients per IEEE C62.41, Category A. Unless otherwise indicated, the minimum number of ballasts shall be used to serve each individual fixture, using one, two, three or four lamp ballasts. A single ballast may be used to serve multiple fixtures if they are continuous mounted, factory manufactured for that installation with an integral wireway, and are identically controlled.
 - (a) Light output regulation shall be +/- 10%.
 - (b) Voltage input regulation shall be +/- 10%.
 - (c) Lamp current crest factor shall be no more than 1.6.
 - (d) Ballast factor shall be not less than 85% nor more than 100%, unless otherwise indicated.
 - (e) A 60 Hz filter shall be provided. Flicker shall be no more than 10% with any lamp suitable for the ballast.
 - (f) Ballast case temperature shall not exceed 25 degree Celsius rise above 40 degree Celsius ambient, when tested in accordance with UL 935.

- (g) Total harmonic distortion shall not be more than 10.
- (h) Power factor shall not be less than 0.95.
- (i) Ballasts shall operate at a frequency of 20 kHz or more.
- (j) Operating filament voltage shall be 2.5 to 4.5 volts.
- (k) Warranty. Three year full warranty including a \$10 labor allowance.
- (l) Ballast Efficacy Factor (BEF) shall be in accordance with the following table. Ballasts and lamps shall be matching rapid start or instant start as indicated on the following table. If 32W-F32-T8 lamps and ballasts are used, they must be either all rapid start or all instant start.

ELECTRONIC FLUORESCENT BALLAST EFFICACY FACTORS*

LAMP TYPE	TYPE OF STARTER & LAMP	NOMINAL OPERATIONAL INPUT VOLTAGE	NUMBER OF LAMPS	MIN. BALLAST EFFICACY FACTOR
40W F40 T12	rapid start	120 or 277 V	1	2.3
			2	1.2
			3	0.8
			4	0.6
34W F40 T12	rapid start	120 or 277 V	1	2.6
			2	1.3
			3	1.0
			4	0.7
40W F40 T10	rapid start	120 or 277 V	1	2.2
			2	1.1
			3	0.8
32W F32 T8	rapid or instant start	120 or 277 V	1	2.4
			2	1.4
			3	1.0
			4	0.8

*For ballasts not specifically designed for use with dimming controls

The BEF is calculated using the formula:

BEF = Ballast Factor (in percent) / Power Input

Where Power Input = Total Wattage of Combined Lamps and Ballasts.

- c. Lampholders, Starters, and Starter Holders: UL 542.

2.10.4 High-Intensity-Discharge

- a. Fixture: NEMA LE 4 for ceiling compatibility of recessed fixtures and UL 1572.
- b. Ballasts: ANSI C82.4 for multiple supply types and UL 1029.

2.11 LOW-VOLTAGE FUSES AND FUSEHOLDERS

2.11.1 Fuses, Low Voltage Cartridge Type

NEMA FU 1.

2.11.2 Fuse Cabinet.

Furnish and install a wall-mounted fuse cabinet containing low voltage spare fuses and a fuse puller suitable for each type fuse on the project. Medium voltage fuses will be stored in the switchgear.

2.11.3 Fuses, High-Interrupting-Capacity, Current-Limiting Type

Fuses, Class G, J, L and CC shall be in accordance with UL 198C.

2.11.4 Fuses, Class R

UL 198E.

2.11.5 Fuses for Supplementary Overcurrent Protection

UL 198G.

2.11.6 Fuses, D-C for Industrial Use

UL 198L.

2.11.7 Fuseholders

UL 512.

2.12 INSTRUMENTS, ELECTRICAL INDICATING

ANSI C39.1.

2.13 MOTORS, AC, FRACTIONAL AND INTEGRAL

Motors, ac, fractional and integral horsepower, 500 hp and smaller shall conform to NEMA MG 1 and UL 1004 for motors and NEMA MG 10 for energy management selection of polyphase motors.

2.13.1 Rating

The horsepower rating of motors should be limited to no more than 125 percent of the maximum load being served unless a NEMA standard size does not fall within this range. In this case, the next larger NEMA standard motor size should be used.

2.13.2 Motor Efficiencies

All permanently wired polyphase motors of 1 hp or more shall meet the minimum full-load efficiencies as indicated in the following table, and as specified in this specification. Motors of 1 hp or more with open, drip proof or totally enclosed fan cooled enclosures shall be high efficiency type, unless otherwise indicated. Motors provided as an integral part of motor driven equipment are excluded from this requirement if a minimum seasonal or overall efficiency requirement is indicated for that equipment by the provisions of another section.

Minimum Motor Efficiencies

HP	Std. Efficiency	High Efficiency
1	77.0	85.5
1.5	78.5	85.5
2	78.5	85.5
3	78.5	88.5
5	82.5	88.5
7.5	84.0	90.0
10	85.5	90.0
15	85.5	91.0
20	87.5	92.0
25	88.5	92.0
30	88.5	92.0
40	88.5	92.0
50	89.0	92.5
60	89.0	92.5
75	89.0	95.5
100	90.0	93.5
125	91.0	94.5
150	91.0	94.5
200	91.0	94.5
250	91.0	94.5
300	91.0	94.5
350	91.0	94.5
400	91.0	94.5
500	91.0	94.5

2.14 MOTOR CONTROLS

2.14.1 General

NEMA ICS 1, NEMA ICS 2, NEMA ICS 3 and NEMA ICS 6, and UL 508 and UL 845.

2.14.2 Motor Starters

Combination starters shall be provided with fusible switches, current-limiting fuses.

2.14.3 Thermal-Overload Protection

Each motor of 1/8 hp or larger shall be provided with thermal-overload protection. Polyphase motors shall have overload protection in each ungrounded conductor. The overload-protection device shall be provided either integral with the motor or controller, or shall be mounted in a separate enclosure. Unless otherwise specified, the protective device shall be of the manually reset type. Single or double pole tumbler switches specifically designed for alternating-current operation only may be used as manual controllers for single-phase motors having a current rating not in excess of 80 percent of the switch rating.

2.14.4 Low-Voltage Motor Overload Relays

2.14.4.1 General

Thermal overload relays shall conform to NEMA ICS 2 and UL 508. Overload protection shall be provided either integral with the motor or motor controller, and shall be rated in accordance with the requirements of NFPA 70. Standard units shall be used for motor starting times up to 7 seconds. Slow units shall be used for motor starting times from 8 to 12 seconds. Quick trip units shall be used on hermetically sealed, submersible pumps, and similar motors.

2.14.4.2 Construction

Manual reset type thermal relay shall be melting alloy construction. Automatic reset overload relays are not allowed.

2.14.4.3 Ratings

Voltage ratings shall be not less than the applicable circuit voltage. Trip current ratings shall be established by selection of the replaceable overload device and shall not be adjustable. Manual reset overload relays shall be provided at all locations. Where the motor is located in a constant ambient temperature, and the thermal device is located in an ambient temperature that regularly varies by more than minus 18 degrees F, an ambient temperature-compensated overload relay shall be provided.

2.14.5 Automatic Control Devices

2.14.5.1 Direct Control

Automatic control devices (such as thermostats, float or pressure switches) which control the starting and stopping of motors directly shall be designed for that purpose and have an adequate horsepower rating.

2.14.5.2 Pilot-Relay Control

Where the automatic-control device does not have such a rating, a magnetic starter shall be used, with the automatic-control device actuating the pilot-control circuit.

2.14.5.3 Manual/Automatic Selection

- a. Where combination manual and automatic control is specified and the automatic-control device operates the motor directly, a double-throw, three-position tumbler or rotary switch (marked MANUAL-OFF-AUTOMATIC) shall be provided for the manual control.

- b. Where combination manual and automatic control is specified and the automatic-control device actuates the pilot control circuit of a magnetic starter, the magnetic starter shall be provided with a three-position selector switch marked MANUAL-OFF-AUTOMATIC.
- c. Connections to the selector switch shall be such that; only the normal automatic regulatory control devices will be bypassed when the switch is in the Manual position; all safety control devices, such as low-or high-pressure cutouts, high-temperature cutouts, and motor-overload protective devices, shall be connected in the motor-control circuit in both the Manual and the Automatic positions of the selector switch. Control circuit connections to any MANUAL-OFF-AUTOMATIC switch or to more than one automatic regulatory control device shall be made in accordance with wiring diagram approved by the Contracting Officer unless such diagram is included on the drawings. All controls shall be 120 volts or less unless otherwise indicated.

2.15 PANELBOARDS

Dead-front construction, NEMA PB 1 and UL 67.

2.16 RECEPTACLES

2.16.1 Heavy Duty Grade

NEMA WD 1. Devices shall conform to all requirements for heavy duty receptacles.

2.16.2 Standard Grade

UL 498.

2.16.3 Ground Fault Interrupters

UL 943, Class A or B.

2.16.4 NEMA Standard Receptacle Configurations

NEMA WD 6.

- a. Single and Duplex, 15-Ampere and 20-Ampere, 125 Volt 15-ampere, non-locking: NEMA type 5-15R, locking: NEMA type L5-15R, 20-ampere, non-locking: NEMA type 5-20R, locking: NEMA type L5-20R.

2.17 SPLICE, CONDUCTOR

UL 486C.

2.18 SNAP SWITCHES

UL 20.

2.19 TAPES

2.19.1 Plastic Tape

UL 510.

2.19.2 Rubber Tape

UL 510.

2.20 TRANSFORMERS

Single- and three-phase transformers shall have two windings per phase. Full-capacity standard NEMA taps shall be provided in the primary windings of transformers unless otherwise indicated. Three-phase transformers shall be configured with delta-wye windings, except as indicated.

2.20.1 Transformers, Dry-Type

Transformers shall have 220 degrees C insulation system for transformers 15 kVA and greater, and shall have 180 degrees C insulation system for transformers rated 10 kVA and less, with temperature rise not exceeding 150 degrees C under full-rated load in maximum ambient temperature of 40 degrees C. Transformer of 150 degrees C temperature rise shall be capable of carrying continuously 100 percent of nameplate kVA without exceeding insulation rating.

a. 600 Volt or Less Primary:

NEMA ST 20, UL 506, general purpose, dry-type, self-cooled, ventilated. Provide transformers in NEMA 1 enclosure.

2.20.2 Average Sound Level

The average sound level in decibels (dB) of transformers shall not exceed the following dB level at 12 inches for the applicable kVA rating range listed unless otherwise indicated:

kVA Range	dB Sound Level
1-50	50
51-150	55
151-300	58
301-500	60
501-700	62
701-1000	64
1001-1500	65
1501 & above	70

2.21 WIRING DEVICES

NEMA WD 1 for wiring devices, and NEMA WD 6 for dimensional requirements of wiring devices.

PART 3 EXECUTION

3.1 GROUNDING

Grounding shall be in conformance with NFPA 70, the contract drawings, and the following specifications.

3.1.1 Ground Rods

The resistance to ground shall be measured using the fall-of-potential method described in IEEE Std 81. The maximum resistance of a driven ground shall not exceed 25 ohms under normally dry conditions. If this resistance cannot be obtained with a single rod, additional rods not less than 6 feet on centers, or if sectional type rods are used, additional sections may be coupled and driven with the first rod. In high-ground-resistance, UL listed chemically charged ground rods may be used. If the resultant resistance exceeds 25 ohms measured not less than 48 hours after rainfall, the Contracting Officer shall be notified immediately. Connections below grade shall be fusion welded. Connections above grade shall be fusion welded or shall use UL 467 approved connectors.

3.1.2 Ground Bus

Ground bus shall be provided in the electrical equipment rooms as indicated. Noncurrent-carrying metal parts of transformer neutrals and other electrical equipment shall be effectively grounded by bonding to the ground bus. The ground bus shall be bonded to both the entrance ground, and to a ground rod or rods as specified above having the upper ends terminating approximately 4 inches above the floor. Connections and splices shall be of the brazed, welded, bolted, or pressure-connector type, except that pressure connectors or bolted connections shall be used for connections to removable equipment. Connections shall be bolted type in lieu of thermoweld, so they can be changed as required by additions and/or alterations.

3.1.3 Grounding Conductors

A green equipment grounding conductor, sized in accordance with NFPA 70 shall be provided, regardless of the type of conduit. Equipment grounding bars shall be provided in all panelboards. The equipment grounding conductor shall be carried back to the service entrance grounding connection or separately derived grounding connection. All equipment grounding conductors, including metallic raceway systems used as such, shall be bonded or joined together in each wiring box or equipment enclosure. Metallic raceways and grounding conductors shall be checked to assure that they are wired or bonded into a common junction. Metallic boxes and enclosures, if used, shall also be bonded to these grounding conductors by an approved means per NFPA 70.

3.2 WIRING METHODS

Wiring shall conform to NFPA 70, the contract drawings, and the following specifications. Unless otherwise indicated, wiring shall consist of insulated conductors installed in rigid zinc-coated steel conduit. Wire fill in conduits shall be based on NFPA 70 for the type of conduit and wire insulations specified.

3.2.1 Conduit and Tubing Systems

Conduit and tubing systems shall be installed as indicated. Conduit sizes shown are based on use of copper conductors with insulation types as described in paragraph WIRING METHODS. Minimum

size of raceways shall be 1/2 inch where concealed and 3/4 inch where exposed. Only metal conduits will be permitted when conduits are required for shielding or other special purposes indicated, or when required by conformance to NFPA 70. PVC coated rigid conduit and tubing shall be used in damp, wet or corrosive locations when permitted by NFPA 70 and the conduit or tubing system is provided with appropriate boxes, covers, clamps, screws or other appropriate type of fittings. Electrical metallic tubing (EMT) may be installed only within the office area. EMT may be installed in concrete and grout in dry locations. EMT installed in concrete or grout shall be provided with concrete tight fittings. EMT shall not be installed in damp or wet locations, or the air space of exterior masonry cavity walls. Bushings, manufactured fittings or boxes providing equivalent means of protection shall be installed on the ends of all conduits and shall be of the insulating type, where required by NFPA 70. Only UL listed adapters shall be used to connect EMT to rigid metal conduit, cast boxes, and conduit bodies. Raceways shall be concealed within finished walls, ceilings, and floors unless otherwise shown. Raceways crossing structural expansion joints or seismic joints shall be provided with suitable expansion fittings or other suitable means to compensate for the building expansion and contraction and to provide for continuity of grounding.

3.2.1.1 Pull Wires

A pull wire shall be inserted in each empty raceway in which wiring is to be installed if the raceway is more than 50 feet in length and contains more than the equivalent of two 90-degree bends, or where the raceway is more than 150 feet in length. The pull wire shall be of No. 14 AWG zinc-coated steel, or of plastic having not less than 200 pounds per square inch tensile strength. Not less than 10 inches of slack shall be left at each end of the pull wire.

3.2.1.2 Conduit Stub-Ups

Where conduits are to be stubbed up through concrete floors, a short elbow shall be installed below grade to transition from the horizontal run of conduit to a vertical run. A conduit coupling fitting, threaded on the inside shall be installed, to allow terminating the conduit flush with the finished floor. Wiring shall be extended in rigid threaded conduit to equipment, except that where required, flexible conduit may be used 6 inches above the floor. Empty or spare conduit stub-ups shall be plugged flush with the finished floor with a threaded, recessed plug.

3.2.1.3 Below Slab-on-Grade or in the Ground

Electrical wiring below slab-on-grade shall be protected by a conduit system. Conduit passing vertically through slabs-on-grade shall be rigid steel. Rigid steel installed below slab-on-grade or in the earth shall have a factory-applied polyvinyl chloride, plastic resin, or epoxy coating system of 40 mils.

3.2.1.4 Installing in Slabs Including Slabs on Grade

Conduit installed in slabs-on-grade shall be rigid steel. Conduits shall be installed as close to the middle of concrete slabs as practicable without disturbing the reinforcement. Outside diameter shall not exceed 1/3 of the slab thickness and conduits shall be spaced not closer than 3 diameters on centers except at cabinet locations where the slab thickness shall be increased as approved by the Contracting Officer. Where conduit is run parallel to reinforcing steel, the conduit shall be spaced a minimum of one conduit diameter away but not less than one inch from the reinforcing steel.

3.2.1.5 Changes in Direction of Runs

Changes in direction of runs shall be made with symmetrical bends or cast-metal fittings. Field-made bends and offsets shall be made with an approved hickey or conduit-bending machine. Crushed or deformed raceways shall not be installed. Trapped raceways in damp and wet locations shall be avoided where possible. Care shall be taken to prevent the lodgment of plaster, dirt, or trash in raceways, boxes, fittings and equipment during the course of construction. Clogged raceways shall be cleared of obstructions or shall be replaced.

3.2.1.6 Supports

Except where otherwise permitted by NFPA 70, conduits and tubing shall be securely and rigidly fastened in place at intervals of not more than 10 feet and within 3 feet of boxes, cabinets, and fittings, with approved pipe straps, wall brackets, conduit clamps, conduit hangers, threaded C-clamps, beam clamps, or ceiling trapeze. Loads and supports shall be coordinated with supporting structure to prevent damage or deformation to the structure. Loads shall not be applied to joist bridging. Attachment shall be by wood screws or screw-type nails to wood; by toggle bolts on hollow masonry units; by expansion bolts on concrete or brick; by machine screws, welded threaded studs, heat-treated or spring-steel-tension clamps on steel work. Nail-type nylon anchors or threaded studs driven in by a powder charge and provided with lock washers and nuts may be used in lieu of expansion bolts or machine screws. Raceways or pipe straps shall not be welded to steel structures. Cutting the main reinforcing bars in reinforced concrete beams or joists shall be avoided when drilling holes for support anchors. Holes drilled for support anchors, but not used, shall be filled. In partitions of light steel construction, sheet-metal screws may be used. Raceways shall not be supported using wire or nylon ties. Raceways shall be independently supported from the structure. Upper raceways shall not be used as a means of support for lower raceways. Supporting means will not be shared between electrical raceways and mechanical piping or ducts. Cables and raceways shall not be supported by ceiling grids. Except where permitted by NFPA 70, wiring shall not be supported by ceiling support systems. Conduits shall be fastened to sheet-metal boxes and cabinets with two locknuts where required by NFPA 70, where insulating bushings are used, and where bushings cannot be brought into firm contact with the box; otherwise, a single locknut and bushing may be used. Threadless fittings for electrical metallic tubing shall be of a type approved for the conditions encountered. Additional support for horizontal runs is not required when EMT rests on steel stud cutouts.

3.2.1.7 Exposed Raceways

Exposed raceways shall be installed parallel or perpendicular to walls, structural members, or intersections of vertical planes and ceilings. Raceways under raised floors and above accessible ceilings shall be considered as exposed installations in accordance with NFPA 70 definitions.

3.2.1.8 Communications Raceways

Communications raceways indicated shall be installed in accordance with the previous requirements for conduit and tubing and with the additional requirements that no length of run shall exceed 50 feet for 1/2 inch and 3/4 inch sizes, and 100 feet for 1 inch or larger sizes, and shall not contain more than two 90-degrees bends or the equivalent. Additional pull or junction boxes shall be installed to comply with these limitations whether or not indicated. Inside radii of bends in conduits of 1 inch size or larger shall not be less than ten times the nominal diameter.

3.2.1.9 Sizing

Unless otherwise noted, all sizes are based on copper conductors and the insulation types indicated. Sizes shall be not less than indicated. Branch-circuit conductors shall be not smaller than No. 12 AWG. Conductors for branch circuits of 120 volts more than 100 feet long and of 277 volts more than 230 feet long, from panel to load center, shall be no smaller than No. 10 AWG. Class 1 remote control and signal circuit conductors shall be not less than No. 14 AWG. Class 2 remote control and signal circuit conductors shall be not less than No. 16 AWG. Class 3 low-energy, remote-control and signal circuits shall be not less than No. 22 AWG.

3.2.1.10 Special cables

Resistance temperature detector (RTD) cable shall be comprised of shielded triads, either single or multiple triads, as indicated on the drawings. The individual conductor size shall be No. 16 AWG unless otherwise noted. The cable shall be UL type TC, 600 volt, 90 Degree C. with overall shield. Each conductor in the triad shall be color coded and each triad shall be numbered in multiple triad cables.

3.2.1.11 Cable Splicing

Splices shall be made in an accessible location. Crimping tools and dies shall be approved by the connector manufacturer for use with the type of connector and conductor.

- a. Copper Conductors, 600 Volt and Under: Splices in conductors No. 10 AWG and smaller diameter shall be made with an insulated, pressure-type connector. Splices in conductors No. 8 AWG and larger diameter shall be made with a solderless connector and insulated with tape or heat-shrink type insulating material equivalent to the conductor insulation.
- b. Greater Than 600 Volt: Cable splices shall be made in accordance with the cable manufacturer's recommendations and Section 16375 ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND.

3.2.1.12 Conductor Identification and Tagging

Power, control, and signal circuit conductor identification shall be provided within each enclosure where a tap, splice, or termination is made. Where several feeders pass through a common pull box, the feeders shall be tagged to indicate clearly the electrical characteristics, circuit number, and panel designation. Phase conductors of low voltage power circuits shall be identified by color coding. Phase identification by a particular color shall be maintained continuously for the length of a circuit, including junctions.

- a. Color coding shall be provided for service, feeder, branch, and ground conductors. Color shall be green for grounding conductors and white for neutrals; except where neutrals of more than one system are installed in the same raceway or box, other neutral shall be white with colored (not green) stripe. The color coding for three-phase and single-phase low voltage systems shall be as follows:

120/208-volt, 3-phase: Black(A), red(B), and blue(C).

277/480-volt, 3-phase: Brown(A), orange(B), and yellow(C).

- b. Conductor phase and voltage identification shall be made by color-coded insulation for all conductors smaller than No. 6 AWG. For conductors No. 6 AWG and larger, identification shall be made by color-coded insulation, or conductors with black insulation may be furnished and identified by the use of half-lapped bands of colored electrical tape wrapped around the insulation for a minimum of 3 inches of length near the end, or other method as submitted by the Contractor and approved by the Contracting Officer.
- c. Control and signal circuit conductor identification shall be made by color-coded insulated conductors, plastic-coated self-sticking printed markers, permanently attached stamped metal foil markers, or equivalent means as approved. Control circuit terminals of equipment shall be properly identified. Terminal and conductor identification shall match that shown on approved detail drawings. Hand lettering or marking is not acceptable.

3.3 BOXES AND SUPPORTS

Boxes shall be provided in the wiring or raceway systems where required by NFPA 70 for pulling of wires, making connections, and mounting of devices or fixtures. Pull boxes shall be furnished with screw-fastened covers. Indicated elevations are approximate, except where minimum mounting heights for hazardous areas are required by NFPA 70. Unless otherwise indicated, boxes for wall switches shall be mounted 48 inches above finished floors.

3.3.1 Box Applications

Each box shall have not less than the volume required by NFPA 70 for number of conductors enclosed in box. Boxes for metallic raceways, 4 by 4 inch nominal size and smaller, shall be of the cast-metal hub type when located in normally wet locations, when flush and surface mounted on outside of exterior surfaces. Cast-metal boxes installed in wet locations and boxes installed flush with the outside of exterior surfaces shall be gasketed. Boxes for mounting lighting fixtures shall be not less than 4 inches square, or octagonal, except smaller boxes may be installed as required by fixture configuration, as approved. Cast-metal boxes with 3/32 inch wall thickness are acceptable. Large size boxes shall be NEMA 4 stainless steel construction for exterior use as shown. Boxes in other locations shall be sheet steel. Boxes for use in masonry-block or tile walls shall be square-cornered, tile-type, or standard boxes having square-cornered, tile-type covers.

3.3.2 Brackets and Fasteners

Boxes and supports shall be fastened to wood with wood screws or screw-type nails of equal holding strength, with bolts and metal expansion shields on concrete or brick, with toggle bolts on hollow masonry units, and with machine screw or welded studs on steel work. Threaded studs driven in by powder charge and provided with lockwashers and nuts, or nail-type nylon anchors may be used in lieu of expansion shields, or machine screws. Penetration of more than 1-1/2 inches into reinforced-concrete beams or more than 3/4 inch into reinforced-concrete joists shall avoid cutting any main reinforcing steel. The use of brackets which depend on gypsum wallboard or plasterboard for primary support will not be permitted. In partitions of light steel construction, bar hangers with 1 inch long studs, mounted between metal wall studs or metal box mounting brackets shall be used to secure boxes to the building structure. When metal box mounting brackets are used, additional box support shall be provided on the side of the box opposite the brackets. This additional box support shall consist of a minimum 12 inch long section of wall stud, bracketed to the opposite side of the box and secured by two screws through the wallboard on each side of the stud. Metal screws may be used in lieu of the metal box mounting brackets.

3.3.3 Mounting in Walls, Ceilings, or Recessed Locations

In walls or ceilings of concrete, tile, or other non-combustible material, boxes shall be installed so that the edge of the box is not recessed more than 1/4 inch from the finished surface. Boxes mounted in combustible walls or ceiling material shall be mounted flush with the finished surface. The use of gypsum or plasterboard as a means of supporting boxes will not be permitted. Boxes installed for concealed wiring shall be provided with suitable extension rings or plaster covers, as required. The bottom of boxes installed in masonry-block walls for concealed wiring shall be mounted flush with the top of a block to minimize cutting of the blocks, and boxes shall be located horizontally to avoid cutting webs of block. Separate boxes shall be provided for flush or recessed fixtures when required by the fixture terminal operating temperature, and fixtures shall be readily removable for access to the boxes unless ceiling access panels are provided.

3.3.4 Installation in Overhead Spaces

In open overhead spaces, cast-metal boxes threaded to raceways need not be separately supported except where used for fixture support; cast-metal boxes having threadless connectors and sheet metal boxes shall be supported directly from the building structure or by bar hangers. Hangers shall not be fastened to or supported from joist bridging. Where bar hangers are used, the bar shall be attached to raceways on opposite sides of the box and the raceway shall be supported with an approved type fastener not more than 24 inches from the box.

3.4 DEVICE PLATES

One-piece type device plates shall be provided for all outlets and fittings. Plates on unfinished walls and on fittings shall be of cast-metal, or impact resistant plastic having rounded or beveled edges. Plates on finished walls shall be of impact-resistant nylon and shall be ivory. Screws shall be of metal with countersunk heads, in a color to match the finish of the plate. Plates shall be installed with all four edges in continuous contact with finished wall surfaces without the use of mats or similar devices. Plaster fillings will not be permitted. Plates shall be installed with an alignment tolerance of 1/16 inch. The use of sectional-type device plates will not be permitted. Plates installed in wet locations shall be gasketed and provided with a hinged, gasketed cover, unless otherwise specified.

3.5 RECEPTACLES

3.5.1 Single and Duplex, 15 or 20-ampere, 125 volt

Single and duplex receptacles shall be rated 20 amperes, 125 volts, two-pole, three-wire, grounding type with polarized parallel slots. Bodies shall be of ivory to match color of switch handles in the same room or to harmonize with the color of the respective wall, and supported by mounting strap having plaster ears. Contact arrangement shall be such that contact is made on two sides of an inserted blade. Receptacle shall be side- or back-wired with two screws per terminal. The third grounding pole shall be connected to the metal mounting yoke. Switched receptacles shall be the same as other receptacles specified except that the ungrounded pole of each suitable receptacle shall be provided with a separate terminal. Only the top receptacle of a duplex receptacle shall be wired for switching application. Receptacles with ground fault circuit interrupters shall have the current rating as indicated, and shall be UL Class A type unless otherwise shown. Ground fault circuit protection shall be provided as required by NFPA 70 and as indicated on the drawings.

3.5.2 Clock Outlet

Clock outlet, for use in other than a wired clock system, shall consist of an outlet box, a plaster cover where required, and a single receptacle with clock-outlet plate. The receptacle shall be recessed sufficiently within the box to allow the complete insertion of a standard cap, flush with the plate. A suitable clip or support for hanging the clock shall be secured to the top of the plate. Material and finish of the plate shall be as specified in paragraph DEVICE PLATES.

3.5.3 Weatherproof Applications

Weatherproof receptacles shall be suitable for the environment, damp or wet as applicable, and the housings shall be labeled to identify the allowable use. Receptacles shall be marked in accordance with UL 514A for the type of use indicated; "Damp locations", "Wet Locations", "Wet Location Only When Cover Closed". Assemblies shall be installed in accordance with the manufacturer's recommendations.

3.5.3.1 Damp Locations

Receptacles in damp locations shall be mounted in an outlet box with a gasketed, weatherproof, cast-metal cover plate (device plate, box cover) and a gasketed cap (hood, receptacle cover) over each receptacle opening. The cap shall be either a screw-on type permanently attached to the cover plate by a short length of bead chain or shall be a flap type attached to the cover with a spring loaded hinge.

3.5.3.2 Wet Locations

Receptacles in wet locations shall be installed in an assembly rated for such use whether the plug is inserted or withdrawn, unless otherwise indicated. In a duplex installation, the receptacle cover shall be configured to shield the connections whether one or both receptacles are in use. Assemblies which utilize a self-sealing boot or gasket to maintain wet location rating shall be furnished with a compatible plug at each receptacle location and a sign notifying the user that only plugs intended for use with the sealing boot shall be connected during wet conditions.

3.5.4 Special-Purpose or Heavy-Duty Receptacles

Special-purpose or heavy-duty receptacles shall be of the type and of ratings and number of poles indicated or required for the anticipated purpose. Contact surfaces may be either round or rectangular. One appropriate straight or angle-type plug shall be furnished with each receptacle. Locking type receptacles, rated 30 amperes or less, shall be locked by rotating the plug. Locking type receptacles, rated more than 50 amperes, shall utilize a locking ring.

3.6 WALL SWITCHES

Wall switches shall be of the totally enclosed tumbler type. The wall switch handle and switch plate color shall be ivory. Wiring terminals shall be of the screw type or of the solderless pressure type having suitable conductor-release arrangement. Not more than one switch shall be installed in a single-gang position. Switches shall be rated 20-ampere 120 277-volt for use on alternating current only. Pilot lights indicated shall consist of yoke-mounted candelabra-base sockets rated at 75 watts, 125 volts, and fitted with glass or plastic jewels. A clear 6-watt lamp shall be furnished and installed in each pilot switch. Jewels for use with switches controlling motors shall be green, and jewels for other purposes shall be red. Dimming switches shall be solid-state flush mounted, sized for the loads.

3.7 PANELBOARDS AND LOADCENTERS

Circuit breakers and switches used as a motor disconnecting means shall be capable of being locked in the open position. Door locks shall be keyed alike. Nameplates shall be as approved. Directories shall be typed to indicate loads served by each circuit and mounted in a holder behind a clear protective covering. Busses shall be copper.

3.7.1 Panelboards

Panelboards shall be circuit breaker equipped as indicated on the drawings.

3.8 ANNUNCIATOR PANEL

The Annunciator Panel shall be located in the Office. The annunciator panel shall consist of an industrial grade control panel, NEMA 1, of dimensions shown, with 3-point latch front opening door. Panel shall have interior subpanel painted white for visibility. The exterior of panel shall be painted beige in color. Provide indication lights type NEMA 13 oil-tight pilot lights, push-to-test type as indicated.

3.8.1 Enclosure

The panel shall be constructed from sheet steel and shall have internal support structure to support the door at any open position without deformation or ballooning. The enclosure shall be fabricated to NEMA 12 standards.

3.8.2 Annunciator

Annunciator panel with engraved windows as shown on the Plans. Annunciator shall have provisions for STATUS ONLY and ALARM WARNING selectable for any window on the annunciator. The annunciator shall have a "first out" feature to display which alarm occurred first in a series of alarms. The first out feature shall be ISA Sequence F3A-3 as described below.

Tri-Flash, First Out	Test or First Alert	Subsequent Alert	Acknow- ledge	First Out Reset	Return to Normal
First Out Visual	Intermittent Fast Flashing	Intermittent Fast Flashing	Slow Flashing	Steady On	Off
Subsequent Visual	Off	Fast Flashing	Steady On	Steady On	Off
Audible	On	On	Off	Off	Off

3.8.3 Panel Accessories

A 120 VAC input surge arrestor shall be provided on each AC power input to the panel. An interior top mounted fluorescent light fixture shall be provided with interior switch. A 20 ampere - 120 duplex convenience receptacle shall be provided. All field wiring shall terminate on a terminal strip with markings matching approved shop drawings. Panel wiring shall utilize type SIS or MTW stranded, 600 volt rated copper conductor. Provide wiring channels to train internal wiring and lace and bundle wiring in orderly fashion.

3.9 UNDERGROUND SERVICE

Unless otherwise indicated, interior conduit systems shall be stubbed out 5 feet beyond the building wall and 2 feet below finished grade, for interface with the exterior service lateral conduits and exterior power and control conduits.

3.10 MOTORS

Each motor shall conform to the hp and voltage ratings indicated, and shall have a service factor and other characteristics that are essential to the proper application and performance of the motors under conditions shown or specified. Three-phase motors for use on 3-phase 208-volt systems shall have a nameplate rating of 200 volts. Unless otherwise specified, all motors shall have open frames, and continuous-duty classification based on a 40 degree C ambient temperature reference. Polyphase motors shall be squirrel-cage type, having normal-starting-torque and low-starting-current characteristics, unless other characteristics are specified in other sections of these specifications or shown on contract drawings. The Contractor shall be responsible for selecting the actual horsepower ratings and other motor requirements necessary for the applications indicated. When electrically driven equipment furnished under other sections of these specifications materially differs from the design, the Contractor shall make the necessary adjustments to the wiring, disconnect devices and branch-circuit protection to accommodate the equipment actually installed.

3.11 MOTOR CONTROL

Each motor or group of motors requiring a single control and not controlled from a motor-control center shall be provided under other sections of these specifications with a suitable controller and devices that will perform the functions as specified for the respective motors. Each motor of 1/8 hp or larger shall be provided with thermal-overload protection. Polyphase motors shall have overload protection in each ungrounded conductor. The overload-protection device shall be provided either integral with the motor or controller, or shall be mounted in a separate enclosure. Unless otherwise specified, the protective device shall be of the manually reset type. Single or double pole tumbler switches specifically designed for alternating-current operation only may be used as manual controllers for single-phase motors having a current rating not in excess of 80 percent of the switch rating. Automatic control devices such as thermostats, float or pressure switches may control the starting and stopping of motors directly, provided the devices used are designed for that purpose and have an adequate horsepower rating. When the automatic-control device does not have such a rating, a magnetic starter shall be used, with the automatic-control device actuating the pilot-control circuit. When combination manual and automatic control is specified and the automatic-control device operates the motor directly, a double-throw, three-position tumbler or rotary switch shall be provided for the manual control; when the automatic-control device actuates the pilot control circuit of a magnetic starter, the latter shall be provided with a three-position selector switch marked MANUAL-OFF-AUTOMATIC. Connections to the selector switch shall be such that only the normal automatic regulatory control devices will be bypassed when the switch is in the Manual position; all safety control devices, such as low- or high-pressure cutouts, high-temperature cutouts, and motor-overload protective devices, shall be connected in the motor-control circuit in both the Manual and the Automatic positions of the selector switch. Control circuit connections to any MANUAL-OFF-AUTOMATIC switch or to more than one automatic regulatory control device shall be made in accordance with wiring diagram approved by the Contracting Officer unless such diagram is included on the drawings. All controls shall be 120 volts or less unless otherwise indicated.

3.11.1 Contacts

Unless otherwise indicated, contacts in miscellaneous control devices such as float switches, pressure switches, and auxiliary relays shall have current and voltage ratings in accordance with NEMA ICS 2 for rating designation B300.

3.11.2 Float Switches

Where indicated for pump control, furnish and install tilt type, double pole float switches for operation in water. The switches shall be rated for operation of 120 volt pilot controls such as motor starters. Factory leads shall be furnished with length to reach motor starter or junction box as indicated on the drawings. Leads shall be three conductor, No. 16 AWG minimum.

3.12 MOTOR-DISCONNECT MEANS

Each motor shall be provided with a disconnecting means when required by NFPA 70 even though not indicated. For single-phase motors, a single or double pole toggle switch, rated only for alternating current, will be acceptable for capacities less than 30 amperes, provided the ampere rating of the switch is at least 125 percent of the motor rating. Switches shall disconnect all ungrounded conductors. For three-phase motors, a three pole, heavy duty disconnect switch shall be installed. The switch shall be fused or non-fused as indicated on the drawings. Interior switches shall be of NEMA 1 construction. Exterior and wet location switches shall be NEMA 4, stainless steel enclosures.

Where shown, the NEMA 4 stainless steel disconnect switch designed to supply alternate standby generator power shall be installed. This switch shall be rated as indicated on the drawings. The switch shall be constructed with a key interlock system designed to positively prevent closing the switch unless the key is inserted and retained. The intent is to prevent simultaneous closing of the generator disconnect switch and the Motor Control Center main disconnect switch. Refer to Section 16403 MOTOR CONTROL CENTERS. The key system for this switch shall be identical and of the same manufacture as the one furnished with the Motor Control System. The key scheme shall allow only one of two switches to close. The closed switch shall retain the key necessary to close the switch. Furnish a sealed set of unused keys for storage offsite with the intent that only one key is on-site.

3.13 TRANSFORMER INSTALLATION

Three-phase transformers shall be connected only in a delta-wye or configuration as indicated.

3.14 LAMPS AND LIGHTING FIXTURES

Ballasted fixtures shall have ballasts which are compatible with the specific type and rating of lamps indicated and shall comply with the applicable provisions of the publications referenced.

3.14.1 Lamps

Lamps of the type, wattage, and voltage rating indicated shall be delivered to the project in the original cartons and installed in the fixtures just prior to the completion of the project.

3.14.1.1 Incandescent

Incandescent lamps shall be for 125-volt operation unless otherwise indicated.

3.14.1.2 Fluorescent

Fluorescent lamps for magnetic ballasts shall be as indicated and shall be of a type that will not require starter switches. Lamps shall be of the rapid-start type unless otherwise shown or approved. Fluorescent lamps for electronic ballasts shall be as indicated.

3.14.1.3 High-Intensity-Discharge

High-intensity-discharge lamps shall be the high-pressure sodium type unless otherwise indicated, shown, or approved.

3.14.2 Lighting Fixtures

Fixtures shall be as shown and shall conform to the following specifications and shall be as detailed on Standard Drawing No. 40-06-04, Sheet Nos. 20, 31, 43, 44, 51, 56, 60, 65, and 66 which accompany and form a part of this specification for the types indicated. Refer to the drawings for the fixture schedule. Illustrations shown on these sheets are indicative of the general type desired and are not intended to restrict selection to fixtures of any particular manufacturer. Fixtures of similar designs and equivalent energy efficiency, light distribution and brightness characteristics, and of equal finish and quality will be acceptable if approved. In suspended acoustical ceilings with fluorescent fixtures, the fluorescent emergency light fixtures shall be furnished with self-contained battery packs.

3.14.2.1 Accessories

Accessories such as straps, mounting plates, nipples, or brackets shall be provided for proper installation. Open type fluorescent fixtures with exposed lamps shall have a wire-basket type guard.

3.14.2.2 Suspended Fixtures

Suspended fixtures shall be provided with swivel hangers in order to ensure a plumb installation. Pendants, rods, or chains 4 feet or longer excluding fixture, shall be braced to limit swinging. Bracing shall be 3 directional, 120 degrees apart. Single unit suspended fluorescent fixtures shall have twin-stem hangers. Multiple unit or continuous-row fluorescent units shall have a tubing or stem for wiring at one point, and a tubing or rod suspension provided for each length of chassis including one at each end. Maximum distance between adjacent tubing or stems shall be 10 feet. Rods shall be of not less than 3/16 inch diameter. Flexible raceway shall be installed to each fixture from an overhead junction box. Fixture to fixture wiring installation is allowed only when fixtures are installed end to end in a continuous run.

3.14.2.3 Ceiling Fixtures

Ceiling fixtures shall be coordinated with and suitable for installation in, on, or from the suspended ceiling provided under other sections of these specifications. Installation and support of fixtures shall be in accordance with the NFPA 70 and manufacturer's recommendations. Recessed fixtures shall have adjustable fittings to permit alignment with ceiling panels. Recessed fixtures installed in fire-resistive type of suspended ceiling construction shall have the same fire rating as the ceiling or shall be provided with fireproofing boxes having materials of the same fire rating as the ceiling panels, in conformance with UL-03. Surface-mounted fixtures shall be suitable for fastening to the structural support for ceiling panels.

3.14.2.4 Sockets

Sockets of industrial, strip, and other open type fluorescent fixtures shall be of the type requiring a forced movement along the longitudinal axis of the lamp for insertion and removal of the lamp.

3.14.3 Emergency Light Sets

Emergency light sets shall conform to UL 924 with the number of heads as indicated. Sets shall be permanently connected to the wiring system by conductors installed in short lengths of flexible conduit.

3.15 EQUIPMENT CONNECTIONS

All wiring not furnished and installed under other sections of the specifications for the connection of electrical equipment as indicated on the drawings shall be furnished and installed under this section of the specifications. Connections shall comply with the applicable requirements of paragraph WIRING METHODS. Flexible conduits 3 feet or less in length shall be provided to all electrical equipment subject to periodic removal, vibration, or movement and for all motors. All motors shall be provided with separate grounding conductors. Liquid-tight conduits shall be used in damp or wet locations.

3.15.1 Motors and Motor Control

Motors, motor controls, and motor control centers shall be installed in accordance with NFPA 70, the manufacturer's recommendations, and as indicated. Wiring shall be extended to motors, motor controls, and motor control centers and terminated.

3.15.2 Installation of Government-Furnished Equipment

Wiring shall be extended to all equipment and terminated. No Government-Furnished Equipment is provided on this project.

3.15.3 Equipment Provided Under Other Sections

Wiring shall be extended to the equipment and terminated.

3.16 CIRCUIT PROTECTIVE DEVICES

The Contractor shall calibrate, adjust, set and test each new adjustable circuit protective device to ensure that they will function properly prior to the initial energization of the new power system under actual operating conditions.

3.17 PAINTING AND FINISHING

Field-applied paint on exposed surfaces shall be provided under Section 09900 PAINTING, GENERAL.

3.18 REPAIR OF EXISTING WORK

The work shall be carefully laid out in advance, and where cutting, channeling, chasing, or drilling of floors, walls, partitions, ceiling, or other surfaces is necessary for the proper installation, support, or anchorage of the conduit, raceways, or other electrical work, this work shall be carefully done, and any

damage to building, piping, or equipment shall be repaired by skilled mechanics of the trades involved at no additional cost to the Government.

3.19 FIELD TESTING

Field testing shall be performed in the presence of the Contracting Officer. The Contractor shall notify the Contracting Officer 10 days prior to conducting tests. The Contractor shall furnish all materials, labor, and equipment necessary to conduct field tests. The Contractor shall perform all tests and inspection recommended by the manufacturer unless specifically waived by the Contracting Officer. The Contractor shall maintain a written record of all tests which includes date, test performed, personnel involved, devices tested, serial number and name of test equipment, and test results. All field test reports will be signed and dated by the Contractor.

3.19.1 Safety

The Contractor shall provide and use safety devices such as rubber gloves, protective barriers, and danger signs to protect and warn personnel in the test vicinity. The Contractor shall replace any devices or equipment which are damaged due to improper test procedures or handling.

3.19.2 Ground-Resistance Tests

The resistance of each grounding electrode system shall be measured using the fall-of-potential method defined in IEEE Std 81. Soil resistivity in the area of the grid shall be measured concurrently with the grid measurements. Ground resistance measurements shall be made before the electrical distribution system is energized and shall be made in normally dry conditions not less than 48 hours after the last rainfall. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together below grade. The combined resistance of separate systems may be used to meet the required resistance, but the specified number of electrodes must still be provided.

- a. Single rod electrode - 25 ohms.
- b. Grid electrode - 1 ohm.

3.19.3 Ground-Grid Connection Inspection

All below-grade ground-grid connections will be visually inspected by the Contracting Officer before backfilling. The Contractor shall notify the Contracting Officer 8 hours before the site is ready for inspection.

3.19.4 Cable Tests

The Contractor shall be responsible for identifying all equipment and devices that could be damaged by application of the test voltage and ensuring that they have been properly disconnected prior to performing insulation resistance testing. An insulation resistance test shall be performed on all low and medium voltage cables after the cables are installed in their final configuration and prior to energization. The test voltage shall be 500 volts DC applied for one minute between each conductor and ground and between all possible combinations of conductors. The minimum value of resistance shall be:

$R \text{ in megohms} = (\text{rated voltage in kV} + 1) \times 1000 / (\text{length of cable in feet})$

Each cable failing this test shall be repaired or replaced. The repaired cable system shall then be retested until failures have been eliminated.

3.19.4.1 Medium Voltage Cable Tests

- a. Continuity test.
- b. Insulation resistance test.
- c. DC high-potential test.

3.19.4.2 Low Voltage Cable Tests

- a. Continuity test.
- b. Insulation resistance test.

3.19.5 Metal Enclosed Bus Duct Tests

- a. Insulation Resistance phase-to-phase, all combinations.
- b. Insulation resistance phase-to-ground, each phase.
- c. AC or DC high-potential test.
- d. Phase rotation test.

3.19.6 Motor Tests

- a. Phase rotation test to ensure proper directions.
- b. Operation and sequence of reduced voltage starters.
- c. High potential test on each winding to ground.
- d. Insulation resistance of each winding to ground.
- e. Vibration test.
- f. Dielectric absorption test on motor and starter.

3.19.7 Dry-Type Transformer Tests

The following field tests shall be performed on all dry-type transformers.

- a. Insulation resistance test phase-to-ground, each phase.
- b. Turns ratio test.
- c. Tap settings for proper voltage

3.19.8 Circuit Breaker Tests

The following field tests shall be performed on circuit breakers.

3.19.8.1 Circuit Breakers, Molded Case

- a. Insulation resistance test phase-to-phase, all combinations.
- b. Insulation resistance test phase-to-ground, each phase.
- c. Closed breaker contact resistance test.
- d. Manual operation of the breaker.

3.19.9 Motor Control Centers

- a. Insulation resistance test phase-to-phase, all combinations.
- b. Insulation resistance test phase-to-ground, each phase.
- c. Manual and electrical operational tests.

3.20 OPERATING TESTS

After the installation is completed, and at such time as the Contracting Officer may direct, the Contractor shall conduct operating tests for approval. The equipment shall be demonstrated to operate in accordance with the specified requirements. An operating test report shall be submitted in accordance with paragraph FIELD TEST REPORTS.

3.21 FIELD SERVICE

3.21.1 On-site Training

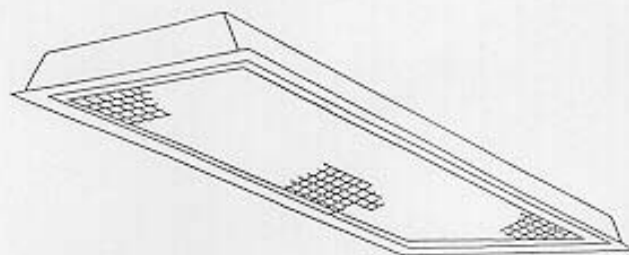
The Contractor shall conduct a training course for the operating staff as designated by the Contracting Officer. The training period shall consist of a total of 16 hours of normal working time and shall start after the system is functionally completed but prior to final acceptance tests. The course instruction shall cover pertinent points involved in operating, starting, stopping, servicing the equipment, as well as all major elements of the operation and maintenance manuals. Additionally, the course instructions shall demonstrate all routine maintenance operations. A VHS format video tape of the entire training shall be submitted.

3.21.2 Installation Engineer

After delivery of the equipment, the Contractor shall furnish one or more field engineers, regularly employed by the equipment manufacturer to supervise the installation of equipment, assist in the performance of the onsite tests, oversee initial operations, and instruct personnel as to the operational and maintenance features of the equipment.

3.22 ACCEPTANCE

Final acceptance of the facility will not be given until the Contractor has successfully completed all tests and after all defects in installation, material or operation have been corrected.



TYPE 206
Static Troffer

TYPE 207
Air Handling Troffer

Recessed Fluorescent Fixture, 2-foot by 4-foot

First Suffix	Second Suffix	Third Suffix	Description
A			Two lamps
B			Three lamps
C			Four lamps
	1		Prismatic acrylic lens
	2		1/2- by 1/2- by 1/2-inch cube louver
	3		1/2- by 1/2- by 1/2-inch polystyrene cube louver
		A	Type 200 emergency unit

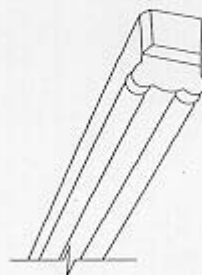
Fixture shall conform to UL 1570. Housing shall be complete with integral side trim flanges. Housing and trim flanges shall be cold-rolled steel. The lens or louver shall be installed in a manner that will prevent it from coming loose due to vibration. The ballasts and wiring shall be enclosed in a wireway that is continuous throughout the length of the fixture and which forms a wireway for circuits through the fixture. All metal parts shall receive a rust inhibitive coating before application of the finish coat. The finish coat shall be baked enamel. Lenses and acrylic cube louvers shall be 100 percent virgin acrylic plastic. The lens or louver shall be four feet in length. Acrylic lens shall be flat, 0.125 inch nominal thickness, low brightness, with smooth top surface and a lower surface having a regular array of prismatic elements. Two-lamp ballasts shall be used for individually mounted two-lamp fixtures. Standard ballast(s) shall be the Class P, high power factor type which has been approved for the application by the Certified Ballast Manufacturers. Fixture shall be prewired.

Fixture types indicated on this sheet shall also conform to requirements specified and indicated in the contract documents.

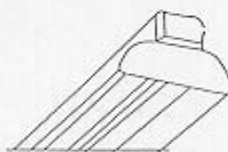
SEPTEMBER 1991
CHANGE 1

STD. DET. NO. 40-06-04

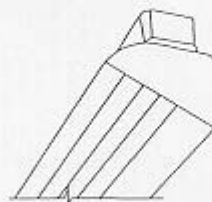
SHEET 20



TYPE 220
Without
Reflector



TYPE 221
With Symmetric
Reflector



TYPE 222
With Asymmetric
Reflector

Single- and Two-Lamp Fluorescent Strip Fixture

Suffix	Description
A	One lamp
B	Two lamps

Fixture shall be constructed of cold-rolled steel and shall conform to UL 1570. The fixture shall have a die-formed steel channel, suitable mounting holes, and 1/2-inch knockouts in back. Channel and end fittings shall have a baked white enamel finish. The channel and end fittings shall be removed to permit the installation of a continuous row of fixtures, the closure of fixtures at the ends of continuous rows, and the closure of the ends of individually mounted fixtures with no light leakage. Channel covers shall have threaded fittings for reflector mounting, shall be constructed of die-formed steel, and shall be finished with baked white enamel. All ferrous metal parts shall receive a rust inhibitive coating before application of finish coat. Reflectors shall be designed for direct attachment to the channel cover with suitable threaded fittings. Reflectors shall be manufacturer's standard commercial product and shall be constructed of die-formed aluminum with highly polished finish, or steel with white porcelain enamel finish, or steel with baked white enamel finish. Fixture shall be suitable for pendant and surface mounting. Standard ballast(s) shall be the Class P, high power factor type which has been approved for the application by the Certified Ballast Manufacturers. Fixture shall be prewired. Sockets shall be of the type requiring a forced movement along the longitudinal axis of the lamp for insertion and removal of the lamp. Fluorescent tubes shall be protected by a virgin acrylic protective sleeve and clear plastic vented end caps.

Fixture types indicated on this sheet shall also conform to requirements specified and indicated in the contract documents.

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SHEET 31



TYPE 301
High Bay



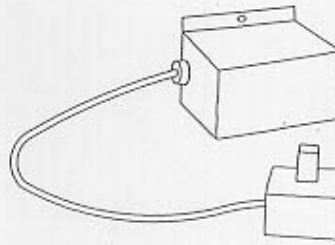
TYPE 302
Low Bay

Enclosed, Pendant, Integrally Ballasted, Industrial,
High Intensity Discharge Fixture

First Suffix	Second Suffix	Description
A		Rated for metal halide lamp
B		Rated for high pressure sodium lamp
	1	Type 300 emergency quartz standby

Fixture shall conform to UL 1572. The ballast housing and structural parts, including the mounting devices, shall be of cast aluminum. The optical assembly shall be enclosed, gasketed, and locked to the ballast housing by a positive vibration-proof means. An optical assembly filter to permit the passage of air during heating and cooling cycles shall be provided. All exposed cast aluminum parts shall have a baked enamel paint finish. The lens shall be heat and impact resistant glass mounted in a gasketed, hinged aluminum door frame. Ballast shall be of the high power factor type. Fixture shall be prewired. Ballast shall start and operate the lamp in an ambient temperature range of minus 20 degrees F to 105 degrees F. Metal halide fixture shall use a lead-peaked autotransformer ballast. High pressure sodium fixture shall use a regulated type ballast. Reflector shall be constructed of aluminum and contoured or formed to provide high lighting efficiency. The exterior of the reflector shall have a clear acrylic lacquer protective coating. The interior of the reflector shall be the manufacturer's standard commercial product finish suitable for light source provided. The fixture shall have a mogul base glazed porcelain lampholder, adjustable for varying the spacing-to-mounting-height ratio in the field. The fixture shall have separate, removable mounting components that can be easily removed and assembled to the structural or mounting hardware before mounting the remainder of the fixture.

Fixture types indicated on this sheet shall also conform to requirements specified and indicated in the contract documents.



TYPE 300

Emergency 250 Watt Quartz Standby Light System
For High Intensity Discharge Fixtures

Emergency quartz standby system shall be the delayed type which shall provide standby illumination when the high intensity discharge fixture is energized, following a prolonged period of deenergization. The system shall also automatically cause the energization of the quartz lamp when the input voltage supplied to the fixture drops below the voltage required to maintain the arc in the lamp through the output of the ballast. The system shall deenergize the quartz lamp when the high intensity discharge lamp reaches 40 percent of its rated lumen output. The system shall be provided by the high intensity discharge fixture manufacturer, shall be a separate attachment as illustrated or integrally incorporated into the fixture components, and shall be factory installed and prewired. Maximum power required for the fixture during periods when both lamps are energized shall be indicated on the fixture nameplate. The system shall include step-down transformer if the system operates at a voltage rating different from the voltage rating specified or indicated for the high intensity discharge fixture.

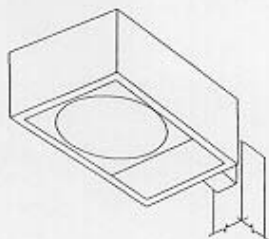
The standby system indicated on this sheet shall be provided as indicated on other sheets and shall also conform to requirements specified and indicated in the contract documents.

Fixture type indicated on this sheet shall also conform to requirements specified and indicated in the contract documents.

FEBRUARY 1991

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SHEET 43



TYPE 401

Enclosed, Integrally Ballasted, Rectangular Shaped,
Side Mounted, High Intensity Discharge Lighting Fixture

First Suffix	Second Suffix	Description
A		Rated for mercury vapor lamp
B		Rated for metal halide lamp
C		Rated for high pressure sodium lamp
	1	IES type II medium light distribution
	2	IES type III medium light distribution
	3	IES type V medium light distribution.

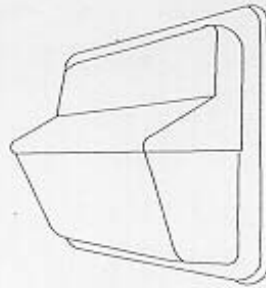
Fixture shall conform to UL 1572. Fixture housing shall have sides and doorframe of one-piece extruded aluminum with welded joints and top of crowned sheet aluminum. The top shall be spot welded and sealed watertight. The housing shall be rigidly attached to a square shaped mounting arm of extruded aluminum. The fixture door shall have a flat heat and impact resistant lens of 3/16-inch nominal, tempered glass, and shall be hinged and held in place with captive screws of the same finish as the door. The lens and door shall enclose the lamp compartment. The reflector shall be aluminum of the manufacturer's standard commercial product finish suitable for the lamp type and rating. The ballast shall be of the high power factor type. The ballast and power components shall be mounted on a single bracket and shall be removable. The fixture, including the mounting arm, shall be gasketed to allow air movement but prevent the entry of dust and insects. Ballast shall be of the constant wattage autotransformer type for mercury vapor lamps, lead-peak autotransformer type for metal halide lamps, and regulating type for high pressure sodium lamps. Ballast shall be capable of starting and operating the lamp at ambient temperatures ranging from minus 20 degrees F to 105 degrees F. A square extruded aluminum pole including anchor type base, anchor bolts and mounting hardware shall be provided by the fixture manufacturer and shall be the manufacturer's standard commercial product for the number of fixtures and wind load indicated or specified. The fixture housing mounting arm shall have a dark duranodic bronze finish. The fixture shall be prewired and shall have a mogul base glazed porcelain lampholder.

Fixture type indicated on this sheet shall also conform to requirements specified and indicated in the contract documents.

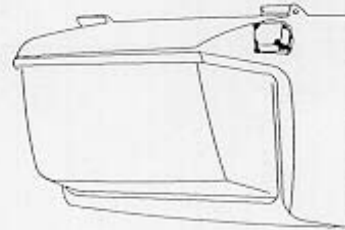
FEBRUARY 1991

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SHEET 51



TYPE 501



TYPE 502

High Intensity Discharge Fixture for Exterior Wall Mounting,
Medium Output

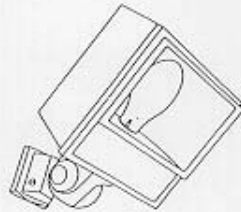
Suffix	Description
A	Rated for: 50 watt high pressure sodium lamp
B	70 watt high pressure sodium lamp
C	100 watt high pressure sodium lamp
D	150 watt high pressure sodium lamp
E	175 watt metal halide lamp

Fixture shall conform to UL 1572 and shall be rated for use in wet locations. The fixture housing, door assembly, and backplate shall be die-cast aluminum. The door assembly shall have integral cast aluminum hinges. The door assembly shall be held securely to the fixture housing with a stainless steel safety strap when the door is in the open position. The door assembly shall be held firmly against a sealing gasket between the fixture door and housing by stainless steel latches or with stainless steel or brass captive screws when the fixture door is closed. The refractor shall be prismatic borosilicate glass or polycarbonate resin. The refractor shall be gasketed and securely held in the door frame, but shall be easily removed for replacement with a common tool. The reflector shall be aluminum with the manufacturer's standard commercial product finish suitable for the type and rating of the lamp. The fixture shall have manufacturers standard protective coating. Cast knockouts shall be provided in the backplate for recessed outlet box mounting. Ballast shall be of the high power factor type. Ballast shall be of the lead-peak autotransformer type metal halide for lamps and the regulating type for high pressure sodium lamps. Ballast shall be capable of starting and operating the lamp at ambient temperatures from minus 20 degrees F to 105 degrees F. The fixture shall be prewired, and shall have a field adjustable, mogul base glazed porcelain lampholder.

Fixture types indicated on this sheet shall also conform to requirements specified and indicated in the contract documents.

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TYPE 506
Wall Bracket Mounting



TYPE 507
Slip Fitter Mounting

High Intensity Discharge Floodlight with Asymmetrical Light Distribution

First Suffix	Second Suffix	Third Suffix	Description
A			Rated for metal halide lamp
B			Rated for high pressure sodium (HPS) lamp
	1		NEMA type 6 x 5 light distribution
	2		NEMA type 7 x 7 light distribution
	3		NEMA type 7 x 6 light distribution
		A	Fixture with instant restrike feature
		B	Type 300 emergency unit

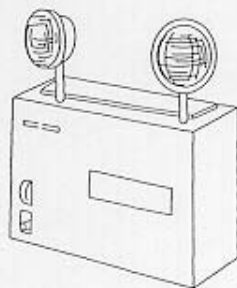
Fixture shall conform to UL 1572 and NEMA FA 1, and shall be the heavy-duty, enclosed type. Fixture shall consist of a cast aluminum housing and a cast aluminum door assembly and shall be integrally ballasted unless otherwise shown or approved. The door assembly shall be hinged and gasketed and held in a closed position with screws of finish to match fixture or recessed stainless steel latches. The lens shall be thermal shock and impact resistant tempered glass and shall be held securely in the door frame. Reflector shall be aluminum with manufacturer's standard commercial product finish suitable for light source provided. All metallic parts of the fixture shall receive one or more rust-inhibitive coatings prior to the application of interior and exterior finishes in accordance with the standard practice of the manufacturer for commercially available exterior lighting fixtures. Ballast shall be of the high power factor type capable of starting and operating the lamp in an ambient temperature of minus 20 degrees F to 105 degrees F. Ballast shall be of the lead-peak autotransformer type for metal halide lamps and the regulating type for high pressure sodium lamps. If an instant restrike feature is specified, the fixture shall be equipped to permit restarting of the lamp to full lumen output within 5 seconds following restoration of power after each momentary power interruption. The fixture shall be prewired and shall include a mogul base glazed porcelain lampholder. Mounting hardware for the fixture shall be adjustable, and shall be the cast aluminum type unless otherwise approved.

Fixture types indicated on this sheet shall also conform to requirements specified and indicated in the contract documents.

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SHEET 60



TYPE 603

6-Volt Emergency Battery Pack Unit with Two Floodlights

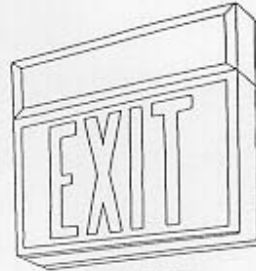
Unit shall conform to UL 924, NFPA 101, and shall meet or exceed the NFPA 70 time and voltage requirements. The unit shall be dual-rated for use on either 120-Volt or 277-Volt alternating current power supplies. Following sustained loss of the normal power supply, the unit shall be capable of automatically and instantaneously illuminating the two 6-Volt lighting fixtures for a period of not less than 90 minutes at a battery voltage in excess of 87.5 percent of the nominal voltage rating. The battery shall be the nickel-cadmium, pocket plate type designed to be maintenance free during the expected battery life, and shall be warranted for not less than 3 years from the date of the purchase of the unit, and shall be field replaceable without requiring removal of other components. The battery charger shall be the solid-state type and shall provide a continuous, variable, current limited, filtered and regulated charge rate. The battery and charger shall be contained in a steel cabinet not less than 18 gauge thickness with an enamel finish, unless otherwise approved, which shall be equipped with a push-to-test switch and a meter to indicate battery voltage when the switch is closed. Mounting brackets or shelf shall be provided, complete with all mounting hardware, all with a finish to match the finish or color of the cabinet. The unit shall be prewired and equipped with two 6-volt, 5-8 watt floodlights as indicated.

Fixture type indicated on this sheet shall also conform to requirements specified and indicated in the contract documents.

SEPTEMBER 1991
CHANGE 1

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SHEET 65



TYPE 604

Exit Sign With Self-Contained Emergency Battery

First Suffix	Second Suffix	Description
A		Single face
B		Double face
	1	End mounted
	2	Top mounted
	3	Back mounted
	4	Stem mounted

Unit shall conform to UL 924, NFPA 101, and shall meet or exceed the NFPA 70 time and voltage requirements. The unit shall be dual-rated for use on either 120-Volt or 277-Volt alternating current power supplies. Following sustained loss of the normal power supply, the unit shall be capable of automatically and instantaneously illuminating the two 6-Volt lighting fixtures for a period of not less than 90 minutes at a battery voltage in excess of 87.5 percent of the nominal voltage rating. The battery shall be the nickel-cadmium, pocket plate type designed to be maintenance free during the expected battery life, and shall be warranted for not less than 3 years from the date of the purchase of the unit, and shall be field replaceable without requiring removal of other components. The battery charger shall be the solid-state type and shall provide a continuous, variable, current limited, filtered and regulated charge rate. The battery and charger shall be contained in a steel cabinet not less than 18 gauge thickness with an enamel finish, unless otherwise approved, which shall be equipped with a push-to-test switch and a meter to indicate battery voltage when the switch is closed. Mounting brackets or shelf shall be provided, complete with all mounting hardware, all with a finish to match the finish or color of the cabinet. All ferrous metal parts shall receive a rust inhibitive coating before application of the finish coat. The fixture shall have a light-emitting diode pilot light to show that the battery charger is functioning. Fixture shall be prewired, with wiring concealed in the illuminated portion of the fixture housing.

Fixture type indicated on this sheet shall also conform to requirements specified and indicated in the contract documents.

SEPTEMBER 1991
CHANGE 1

STD. DET. NO. 40-06-04

SHEET 66

End of Section

APPENDIX #1 TO SECTION 16415
MOTOR CERTIFICATION DATA

**US ARMY Corps of Engineers
New Madrid Pump Station**

MOTOR TEST REPORT

Each electric motor shall be tested for proper operation. Follow manufacturer's testing recommendations and procedures.

1. Name of Motor Tested
2. Visual Inspection Checklist
Motor Frame Bolts
Shaft Coupling
Lubricants
Other Comments:
3. Megger motor from wire in motor control center or control panel and record results.
 $\phi A - \phi B$ ____ $\phi B - \phi C$ ____ $\phi C - \phi A$
 $\phi A - G$ ____ $\phi B - G$ ____ $\phi C - G$
4. Momentarily bump motor shaft for proper rotation.

IF APPLICABLE, RECORD THE FOLLOWING INFORMATION.

5. Current Transformer Ratios
CT Phase A ____ CT Phase B ____ CT Phase C
6. Potential Transformer Ratios
Phase a-b ____ Phase b-c ____ Phase b-c

Comments:

Contractor's Authorized Representative (Signature
Required)

Date

Commissioning Summary

MOTOR NAME _____

Page 1:SETPOINT VALUES MOTOR AMPS SETPOINTS	Page 2:SETPOINT VALUES RTD SETPOINTS	Page 3:SETPOINT VALUES O/L CURVE SETPOINTS	Page 4:SETPOINT VALUES RELAY CONFIGURATION
Phase CT Secondary_____	Stator RTD's Used_____	Curve Number_____	O/L Trip
Phase CT Ratio_____	Stat 1 Alarm Level(°C)_____	Trip Time @ 1.05xFLC_____	U/B Trip
Motor FLC(amps)_____	RTD 1 Alarm Level(°C)_____	Trip Time @ 1.10_____	S/C Trip
O/L pickup Level(%)_____	Stat 1 Trip Level(°C)_____	Trip Time @ 1.20_____	Rapid Trip
Accel. Time(secs)_____	RTD 1 Trip Level (°C)_____	Trip Time @ 1.30_____	Stator RTD Trip
Starts/Hour_____	Stat 2 Alarm Level (°C)_____	Trip Time @ 1.40_____	RTD Trip
U/B Alarm Level (%)_____	RTD 2 Alarm Level (°C)_____	Trip Time @ 1.50_____	G/F Trip
U/B Alarm Delay (secs)_____	Stat 2 Trip Level (°C)_____	Trip Time @ 1.75_____	Accel. Time Trip
U/B Trip Level (%)_____	RTD 2 Trip Level (°C)_____	Trip Time @ 2.00_____	Phase Rev. Trip
U/B Trip Delay (secs)_____	Stat 3 Alarm Level (°C)_____	Trip Time @ 2.25_____	Inhibit Lockouts
G/F CT Secondary_____	RTD 3 Alarm Level (°C)_____	Trip Time @ 2.50_____	Speed Switch Trip
G/F CT Ratio_____	Stat 3 Trip Level (°C)_____	Trip Time @ 2.75_____	Differential Trip
G/F Alarm Level (amps)_____	RTD 3 Trip Level (°C)_____	Trip Time @ 3.00_____	Single Phase Trip
G/F Alarm Delay (secs)_____	Stat 4 Alarm Level (°C)_____	Trip Time @ 3.50_____	Spare Input Trip
G/F Trip Level (amps)_____	RTD 4 Alarm Level (°C)_____	Trip Time @ 4.00_____	U/V Trip
G/F Trip Delay (secs)_____	Stat 4 Trip Level (°C)_____	Trip Time @ 4.50_____	PF Trip
U/C Alarm Level (amps)_____	RTD 4 Trip Level (°C)_____	Trip Time @ 5.00_____	O/L Warning
U/C Alarm Delay (secs)_____	Stat 5 Alarm Level (°C)_____	Trip Time @ 5.50_____	G/F Alarm
Rapid Trip (x FLC)_____	RTD 5 Alarm Level (°C)_____	Trip Time @ 6.00_____	U/B Alarm
Rapid Trip Delay (secs)_____	Stat 5 Trip Level (°C)_____	Trip Time @ 6.50_____	U/C Alarm
S/C Trip Level (xFLC)_____	RTD 5 Trip Level (°C)_____	Trip Time @ 7.00_____	Stator RTD Alarm
S/C Trip Delay (secs)_____	Stat 6 Alarm Level (°C)_____	Trip Time @ 7.50_____	RTD Alarm
Immediate O/L (xFLC)_____	RTD 6 Alarm Level (°C)_____	Trip Time @ 8.00_____	No Sensor Alarm
	Stat 6 Trip Level (°C)_____		Self-Test Fail
	RTD 6 Trip Level (°C)_____		Spare Input Alarm
	RTD 7 Alarm Level (°C)_____		TC Alarm
	RTD 7 Trip Level (°C)_____		U/V Alarm
	RTD 8 Alarm Level (°C)_____		PF Alarm
	RTD 8 Trip Level (°C)_____		KVAR Alarm
	RTD 9 Alarm Level (°C)_____		MTM Alarm
	RTD 9 Trip Level (°C)_____		
	RTD 10 Alarm Level (°C)		
	RTD 10 Trip Level (°C)		
	RTD 11 Alarm Level (°C)		
	RTD 11 Trip Level (°C)		
	RTD 12 Alarm Level (°C)		
	RTD 12 Trip Level (°C)		

Contractor's Authorized Representative (Signature
Required)

Date

**Page 5:SETPOINT VALUES
SYSTEM CONFIGURATION**

**Page 6:SETPOINT VALUES
SERVICE CODES**

**Page 7:SETPOINT VALUES
METERING SETPOINTS**

Norm Run Disp Line _____
Norm Run Disp Page _____
Defeat No Sensor Alarm _____
Defeat RTD Input _____
RTD Bias Curve Min (°C) _____
RTD Bias Center (%) _____
RTD Bias Center Temp (°C) _____
RTD Bias Curve Max (°C) _____
Defeat U/B Input _____
Defeat K Value _____
Defeat Learned Cool Time _____
Running Cool Time (min) _____
Stopped Cool Time (min) _____
RTD 10 Ambient Sensor _____
Defeat Speed Switch _____
Speed Switch Delay (sec) _____
Analog Output _____
Analog Output Type _____
Single Shot Restart _____
Start Inhibit _____
Special Ext Reset _____
Relay Alarm Latchcode _____
Drawout Failsafe Code _____
Relay Failsafe Code _____
Sp. Inp. Read 52B _____
Sp. Inp. Alarm Delay (sec) _____
Sp. Inp. Trip Delay (sec) _____
Backspin Timer Delay (min) _____
Time Between Starts (min) _____
FLC Therm Cap. Red. (%) _____
TC Used Alarm Level (%) _____
TC Used Alarm Delay (sec) _____
Slave Address _____

Applicable to Service
Application Only.

Setpoints Set/On Line?
MTM CT Primary (amps)
V.T. Ratio
U/V Alarm Level (%)
U/V Alarm Delay (sec)
U/V Trip Level (%)
U/V Trip Delay (sec)
PF Protection Delay (sec)
PF Lead Alarm Level
PF Lag Alarm Level
PF Alarm Delay (sec)
PF Lead Trip Level
PF Lag Trip Level
PF Trip Delay (sec)
KVAR Alarm Level
KVAR Alarm Delay
Voltage Phase Rev.?
Scale Factor

Contractor's Authorized Representative (Signature
Required)

Date

DIVISION 16 - ELECTRICAL

SECTION 16475

COORDINATED POWER SYSTEM PROTECTION

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SECTION 16475

COORDINATED POWER SYSTEM PROTECTION

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C37.46 (1981; R 1992) Power Fuses and Fuse Disconnecting Switches

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C37.2 (1996) Electrical Power System Device Function Numbers

IEEE Std 242 (1986; R 1991) IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems

IEEE Std 399 (1997) Recommended Practice for Industrial and Commercial Power Systems Analysis

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA FU 1 (1986) Low Voltage Cartridge Fuses

NEMA SG 2 (1993) High Voltage Fuses

UNDERWRITERS LABORATORIES (UL)

UL 198C (1986; Rev thru Jun 1993) High-Interrupting-Capacity Fuses, Current-Limiting Types

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Fault Current and Protective Device Coordination Study; GA.

The study along with protective device equipment submittals. No time extensions or similar contract modifications will be granted for work arising out of the requirements for this study. Approval of protective devices proposed will be based on recommendations of this study. The Government shall not be held responsible for any changes to equipment, device ratings, settings, or additional labor for installation of equipment or devices ordered and/or procured prior to approval of the study.

Equipment Performance; GA.

Data consisting of manufacturer's time-current characteristic curves for individual protective devices, recommended settings of adjustable protective devices, and recommended ratings of non-adjustable protective devices. Utilize references as required in IEEE C37.2 where applicable.

Professional Engineer; FIO.

Verification of experience and license number, of a registered Professional Engineer with at least four years of current experience in the design of coordinated power system protection. Experience data shall include at least five references for work of a magnitude comparable to this contract, including points of contact, addresses and telephone numbers. This engineer must perform items required by this section to be performed by a registered Professional Engineer.

SD-06 Instructions

Preventive Maintenance and Inspection; GA.

Data shall including calibration and testing procedures and instructions pertaining to the frequency of calibration, inspection, adjustment, cleaning, and lubrication.

Installation Procedures; GA.

Procedures including diagrams, instructions, and precautions required to properly install, adjust, calibrate, and test the devices and equipment.

SD-09 Reports

Field Testing; GA.

The proposed test plan, prior to field tests. Plan shall consist of complete field test procedure including tests to be performed, test equipment required, and tolerance limits, including complete testing and verification of the ground fault protection equipment, where used. Performance test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Each test report shall indicate the final position of controls.

SD-13 Certificates

Devices and Equipment; GA.

Certificates certifying that all devices or equipment meet the requirements of the contract documents.

1.3 SYSTEM DESCRIPTION

The power system covered by this specification consists of: Medium Voltage Electrical System, Motor Control Center, Panelboards furnished and installed under this contract. The coordination study also includes coordination with M&A Electrical Cooperative for the substation device providing 4160 power to the project.

1.4 QUALIFICATIONS

1.4.1 System Coordinator

System coordination, recommended ratings and settings of protective devices, and design analysis shall be accomplished by a registered professional electrical power engineer with a minimum of two years of current experience in the coordination of electrical power systems.

1.4.2 System Installer

Calibration, testing, adjustment, and placing into service of the protective devices shall be accomplished by a manufacturer's product field service engineer or independent testing company with a minimum of two years of current product experience in protective devices.

1.5 DELIVERY, STORAGE, AND HANDLING

Devices and equipment shall be visually inspected when received and prior to acceptance from conveyance. Stored items shall be protected from the environment in accordance with the manufacturer's published instructions. Damaged items shall be replaced.

1.6 PROJECT/SITE CONDITIONS

Devices and equipment furnished under this section shall be suitable for the following site conditions:

1.6.1 Altitude

Altitude: 300

1.6.2 Ambient Temperature

Ambient Temperature: 40 Degree C.

1.6.3 Frequency

Frequency: 60 Hz

1.6.4 Fungus Control

Fungus Control: None

1.6.5 Hazardous Classification

Hazardous Classification: None

1.6.6 Humidity Control

Humidity Control: None

1.6.7 Ventilation

Ventilation: None

1.6.8 Seismic Zone

This facility and its equipment shall be designed for installation in a Seismic Hazard Exposure Group "I" Seismic Zone 3 with $A_v = 0.25$ and in accordance with requirements of SECTION 05900 PROTECTION FOR MECHANICAL, ELECTRICAL EQUIPMENT AND SUSPENDED CEILING SYSTEMS.

1.6.9 Utility Fault Data

The local utility reports the following fault duty at the proposed M&A Electric Power Cooperative (Scott-New Madrid-Mississippi) Substation to be constructed approximately ¼ mile from this facility.

		Positive Sequence Impedance P.U. 100 MVA	
Lilborn 69kV Bus:	Z1	=	0.01213 + j0.07933
69kV Line (6 Miles)			
336.4 MCM, TS1			
6(0.306 + j0.451)0.021		=	0.0386 + j0.0568
Transformer			
10 MVA, 7.5% Z		=	0.1044 + j0.7427
0.075 x 100/10 <u>/82</u>			
Total to 4.16 kV Bus		=	0.1551 + j0.8789
		=	0.8924/ <u>80</u>

PART 2 PRODUCTS

2.1 LOW-VOLTAGE FUSES

2.1.1 General

Low-voltage fuses shall conform to NEMA FU 1. Time delay and nontime delay options shall be as specified. Equipment provided under this contract shall be provided with a complete set of properly rated fuses when the equipment manufacturer utilizes fuses in the manufacture of the equipment, or if current-limiting fuses are required to be installed to limit the ampere-interrupting capacity of circuit breakers or equipment to less than the maximum available fault current at the location of the equipment

to be installed. Fuses shall have a voltage rating of not less than the phase-to-phase circuit voltage, and shall have the time-current characteristics required for effective power system coordination.

2.1.2 Cartridge Fuses; Current-Limiting Type

Cartridge fuses, current-limiting type, Class L and RK5 shall have tested interrupting capacity not less than 200,000 amperes. Fuse holders shall be the type that will reject Class H fuses.

- a. Class L fuses shall conform to UL 198C.
- b. Class R fuses shall conform to UL 198E.

2.1.2.1 Continuous Current Ratings (600 amperes and smaller)

Service entrance and feeder circuit fuses (600 amperes and smaller) shall be Class RK1 or RK5, current-limiting, time-delay with 200,000 amperes interrupting capacity.

2.1.2.2 Continuous Current Ratings (greater than 600 amperes)

Service entrance and feeder circuit fuses (greater than 600 amperes) shall be Class L, current-limiting, time-delay with 200,000 amperes interrupting capacity.

2.1.2.3 Motor and Transformer Circuit Fuses

Motor, motor controller, transformer, and inductive circuit fuses shall be Class RK1 or RK5, current-limiting, time-delay with 200,000 amperes interrupting capacity.

2.2 MEDIUM-VOLTAGE AND HIGH-VOLTAGE FUSES

2.2.1 General

Medium-voltage and high-voltage fuses shall conform to NEMA SG 2 and shall be distribution fuse cutouts or power fuses, E-rated current-limiting fuses as shown.

2.2.2 Construction

Units shall be suitable for indoor use. Fuses shall have integral blown-fuse indicators. All ratings shall be clearly visible.

2.2.3 Ratings

Voltage ratings shall be not less than the applicable circuit voltage. Continuous-current ratings shall be as shown.

2.2.3.1 E-Rated, Current-Limiting Power Fuses

E-rated, current-limiting, power fuses shall conform to ANSI C37.46.

2.2.4 SWD Circuit Breakers

Circuit breakers rated 15 amperes or 20 amperes and intended to switch 277 volts or less fluorescent lighting loads shall be marked "SWD."

2.2.5 HACR Circuit Breakers

Circuit breakers 60 amperes or below, 240 volts, 1-pole or 2-pole, intended to protect multi-motor and combination-load installations involved in heating, air conditioning, and refrigerating equipment shall be marked "Listed HACR Type."

2.2.6 Incoming Line Motor Operated Fused Switch

Incoming fused switch shall be coordinated with the requirements of the serving utility, and of the protected motor controllers.

- a. A multifunction relay with characteristics required by SECTION 16405 MEDIUM VOLTAGE ELECTRICAL SYSTEM.

2.3 COORDINATED POWER SYSTEM PROTECTION

Analyses shall be prepared to demonstrate that the equipment selected and system constructed meet the contract requirements for ratings, coordination, and protection. They shall include a fault current analysis, and a protective device coordination study. The studies shall be performed by a registered professional engineer with demonstrated experience in power system coordination in the last three years. The Contractor shall provide a list of references complete with points of contact, addresses and telephone numbers. The selection of the engineer is subject to the approval of the Contracting Officer.

2.3.1 Scope of Analyses

The fault current analysis, and protective device coordination study shall begin at: the source bus and extend down to system buses where fault availability is 10,000 amperes (symmetrical) for building/facility 600 volt level distribution buses.

Determination of Facts

The time-current characteristics, features, and nameplate data for each existing protective device shall be determined and documented. The Contractor shall verify and coordinate with the commercial power company for fault current availability at the site and shall utilize the fault current availability indicated as a basis for fault current studies.

2.3.2 Single Line Diagram

A single line diagram shall be prepared to show the electrical system buses, devices, transformation points, and all sources of fault current (including motor contributions). A fault-impedance diagram or a computer analysis diagram may be provided. Each bus, device or transformation point shall have a unique identifier. If a fault-impedance diagram is provided, impedance data shall be shown. Location of switches and circuit interrupting devices shall be shown on the diagram together with available fault data, and the device interrupting rating.

2.3.3 Fault Current Analysis

2.3.3.1 Method

The fault current analysis shall be performed in accordance with methods described in IEEE Std 242, and IEEE Std 399.

2.3.3.2 Data

Actual data shall be utilized in fault calculations. Bus characteristics, motor speed torque curve and transformer impedance shall be those proposed for use on this contract. Data shall be documented in the report.

2.3.3.3 Fault Current Availability

Balanced three-phase fault, bolted line-to-line fault, and line-to-ground fault current values shall be provided at each voltage transformation point and at each power distribution bus. The maximum and minimum values of fault available at each location shall be shown in tabular form on the diagram or in the report.

2.3.4 Coordination Study

The study shall demonstrate that the maximum possible degree of selectivity has been obtained between devices specified, consistent with protection of equipment and conductors from damage from overloads and fault conditions. The study shall include a description of the coordination of the protective devices in this project. A written narrative shall be provided describing: which devices may operate in the event of a fault at each bus; the logic used to arrive at device ratings and settings; situations where system coordination is not achievable due to device limitations (an analysis of any device curves which overlap); coordination between upstream and downstream devices; and relay settings. Recommendations to improve or enhance system reliability, and detail where such changes would involve additions or modifications to the contract and cost damages (addition or reduction) shall be provided. Composite coordination plots shall be provided on log-log graph paper.

2.3.5 Study report

- a. The report shall include a narrative describing: the analyses performed; the bases and methods used; and the desired method of coordinated protection of the power system.
- b. The study shall include descriptive and technical data for existing devices and new protective devices proposed. The data shall include manufacturers' published data, nameplate data, and definition of the fixed or adjustable features of the existing or new protective devices.
- c. The report shall document utility company data including system voltages, fault MVA, system X/R ratio, time-current characteristic curves, current transformer ratios, and relay device numbers and settings; and existing power system data including time-current characteristic curves and protective device ratings and settings.
- d. The report shall contain fully coordinated composite time-current characteristics curves for each bus in the system, as required to ensure coordinated power system protection between

protective devices or equipment. The report shall include recommended ratings and settings of all protective devices in tabulated form.

- e. The report shall provide the calculation performed for the analyses, including computer analysis programs utilized. The name of the software package, developer, and version number shall be provided.

PART 3 EXECUTION

3.1 COORDINATED POWER SYSTEM PROTECTION REPORT

Furnish the Contracting Officer the report in bound notebooks consisting of six (6) copies. The reports shall be furnished as a prerequisite prior to approval of all medium voltage electrical equipment and the horizontal motor, gear reducer and drainage pump equipment furnished by this contract.

End of Section

DIVISION 16 - ELECTRICAL

SECTION 16670

LIGHTNING PROTECTION SYSTEM

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End of Section Table of Contents

SECTION 16670

LIGHTNING PROTECTION SYSTEM

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C135.30	(1988) Zinc-Coated Ferrous Ground Rods for Overhead or Underground Line Construction
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NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(1999) National Electrical Code
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NFPA 780	(1997) Lightning Protection Code
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UNDERWRITERS LABORATORIES (UL)

UL-03	(1992) Electrical Construction Materials Directory
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UL 96	(1994) Lightning Protection Components
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UL 96A	(1994) Installation Requirements for Lightning Protection Systems
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UL 467	(1993) Grounding and Bonding Equipment
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UL 486A	(1997) Wire Connectors and Soldering Lugs for Use with Copper Conductors
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1.2 GENERAL REQUIREMENTS

1.2.1 Verification of Dimensions

The Contractor shall become familiar with all details of the work, verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing the work. No departures shall be made without the prior approval of the Contracting Officer.

1.2.2 System Requirements

The system furnished under this specification shall consist of the standard products of a manufacturer regularly engaged in the production of lightning protection systems and shall be the manufacturer's

latest UL approved design. The lightning protection system shall conform to NFPA 70 and NFPA 780, UL 96 and UL 96A, except where requirements in excess thereof are specified herein.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-04 Drawings

Lightning Protection System; GA.

Detail drawings consisting of a complete list of material, including manufacturer's descriptive and technical literature, catalog cuts, drawings, and installation instructions. Detail drawings shall demonstrate that the system has been coordinated and will function as a unit. Drawings shall show proposed layout and mounting and relationship to other parts of the work.

SD-13 Certificates

Materials and Equipment; GA.

Where material or equipment is specified to comply with requirements of UL, proof of such compliance. The label of or listing in UL-03 will be acceptable evidence. In lieu of the label or listing, a written certificate from an approved nationally recognized testing organization equipped to perform such services, stating that the items have been tested and conform to the requirements and testing methods of Underwriters Laboratories may be submitted. A letter of findings shall be submitted certifying UL inspection of lightning protection systems provided on the following facility: New Madrid Pumping Station.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 General Requirements

No combination of materials shall be used that form an electrolytic couple of such nature that corrosion is accelerated in the presence of moisture unless moisture is permanently excluded from the junction of such metals. Where unusual conditions exist which would cause corrosion of conductors, conductors with protective coatings or oversize conductors shall be used. Where a mechanical hazard is involved, the conductor size shall be increased to compensate for the hazard or the conductors shall be protected by covering them with molding or tubing made of wood or nonmagnetic material. When metallic conduit or tubing is used, the conductor shall be electrically connected at the upper and lower ends.

2.1.2 Main and Secondary Conductors

Conductors shall be in accordance with NFPA 780 and UL 96 for Class I, Class II, or Class II modified materials as applicable.

2.1.2.1 Copper

Copper conductors used on nonmetallic stacks shall weigh not less than 375 pounds per thousand feet, and the size of any wire in the cable shall be not less than No. 15 AWG. The thickness of any web or ribbon used on stacks shall be not less than No. 12 AWG. Counterpoise shall be copper conductors not smaller than shown on the drawings.

2.1.2.2 Aluminum

Aluminum shall not contact the earth nor shall it be used in any other manner that will contribute to rapid deterioration of the metal. Appropriate precautions shall be observed at connections with dissimilar metals. Aluminum conductors for bonding and interconnecting metallic bodies to the main cable shall be at least equivalent to strength and cross-sectional area of a No. 4 AWG aluminum wire. If perforated strips are used, the strips shall be as much wider than solid strips, as the diameter of the perforations. Aluminum strip for connecting exposed water pipes shall be not less than No. 12 AWG in thickness and at least 1-1/2 inches wide.

2.1.3 Air Terminals

Terminals shall be in accordance with UL 96 and NFPA 780. The tip of air terminals on buildings shall be a minimum of 1 foot above the ridge parapet perimeter.

2.1.4 Ground Rods

Rods made of copper-clad steel shall conform to UL 467 and galvanized ferrous rods shall conform to ANSI C135.30. Ground rods shall be not less than 3/4 inch in diameter and 10 feet in length. Ground rods of copper-clad steel, stainless steel, galvanized ferrous, and solid copper shall not be mixed on the job.

2.1.5 Clamp-Type Connectors

Connectors for splicing conductors shall conform to UL 96, class as applicable, and UL 486A, Class 2, style and size as required for the installation.

2.1.6 Lightning Protection Components

Lightning protection components, such as bonding plates, air terminal supports, clips, and fasteners shall conform to UL 96, classes as applicable.

PART 3 EXECUTION

3.1 INTEGRAL SYSTEM

3.1.1 General Requirements

The lightning protection system shall consist of air terminals, roof conductors, down conductors, ground connections, and grounds, electrically interconnected to form the shortest distance to ground. All conductors on the structures shall be exposed except where conductors are in protective sleeves exposed on the outside walls. Secondary conductors shall interconnect with grounded metallic parts

within the building. Interconnections made within side-flash distances shall be at or above the level of the grounded metallic parts.

3.1.1.1 Air Terminals

Air terminal design and support shall be in accordance with NFPA 780. Terminals shall be rigidly connected to, and made electrically continuous with, roof conductors by means of pressure connectors or crimped joints of T-shaped malleable metal and connected to the air terminal by a dowel or threaded fitting. Air terminals at the ends of the structure shall be set not more than 2 feet from the ends of the ridge or edges and corners of roofs. Spacing of air terminals 1 foot in height on ridges, parapets, and around the perimeter of buildings with flat roofs shall not exceed 25 feet. In specific instances where it is necessary to exceed this spacing, the specified height of air terminals shall be increased not less than 2 inches for each foot of increase over 25 feet. On large, flat or gently sloping roofs, as defined in NFPA 780, air terminals shall be placed at points of the intersection of imaginary lines dividing the surface into rectangles having sides not exceeding 50 feet in length. Air terminals shall be secured against overturning either by attachment to the object to be protected or by means of a substantial tripod or other braces permanently and rigidly attached to the building or structure. Metal projections and metal parts of buildings, smokestacks, and other metal objects that do not contain hazardous materials and that may be struck but not appreciably damaged by lightning, need not be provided with air terminals. However, these metal objects shall be bonded to the lightning conductor through a metal conductor of the same unit weight per length as the main conductor.

3.1.1.2 Roof Conductors

Roof conductors shall be connected directly to the roof or ridge roll. Sharp bends or turns in conductors shall be avoided. Necessary turns shall have a radius of not less than 8 inches. Conductors shall preserve a downward or horizontal course and shall be rigidly fastened every 3 feet along the roof and down the building to ground. All connections shall be electrically continuous. Roof conductors shall be coursed along the contours of flat roofs, ridges, parapets, and edges; and where necessary, over flat surfaces, in such a way as to join each air terminal to all the rest. Roof conductors surrounding tank tops, decks, flat surfaces, and flat roofs shall be connected to form a closed loop.

3.1.1.3 Down Conductors

Down conductors shall be electrically continuous from air terminals and roof conductors to grounding electrodes. Down conductors shall be coursed over extreme outer portions of the building, such as corners, with consideration given to the location of ground connections and air terminals. Each building or structure shall have not less than two down conductors located as widely separated as practicable, at diagonally opposite corners. On rectangular structures having French, flat, or sawtooth roofs exceeding 250 feet in perimeter, there shall be at least one additional down conductor for each 100 feet of perimeter or fraction thereof. On structures exceeding 50 feet in height, there shall be at least one additional down conductor for each additional 60 feet of height or fraction thereof, except that this application will not cause down conductors to be placed about the perimeter of the structure at intervals of less than 50 feet. Additional down conductors shall be installed when necessary to avoid "dead ends" or branch conductors ending at air terminals, except where the air terminal is on a roof below the main protected level and the "dead end" or branch conductor is less than 16 feet in length and maintains a horizontal or downward coursing. Down conductors shall be equally and symmetrically spaced about the perimeter of the structure. Down conductors shall be protected where necessary, to prevent mechanical injury to the conductor.

3.1.1.4 Interconnection of Metallic Parts

Metal doors, windows, and gutters shall be connected directly to the grounds or down conductors using not smaller than No. 6 copper conductor, or equivalent. Conductors placed where there is probability of unusual wear, mechanical injury, or corrosion shall be of greater electrical capacity than would normally be used, or shall be protected. The ground connection to metal doors and windows shall be by means of mechanical ties under pressure, or equivalent.

3.1.1.5 Ground Connections

Ground connections comprising continuations of down conductors from the structure to the grounding electrode shall securely connect the down conductor and ground in a manner to ensure electrical continuity between the two. All connections shall be of the clamp type. There shall be a ground connection for each down conductor. Metal water pipes and other large underground metallic objects shall be bonded together with all grounding mediums. Ground connections shall be protected from mechanical injury. In making ground connections, advantage shall be taken of all permanently moist places where practicable, although such places shall be avoided if the area is wet with waste water that contains chemical substances, especially those corrosive to metal.

3.1.1.6 Grounding Electrodes

A grounding electrode shall be provided for each down conductor located as shown. A driven ground shall extend into the earth for a distance of not less than 10 feet. Ground rods shall be set not less than 3 feet, nor more than 8 feet, from the structures foundation. The complete installation shall have a total resistance to ground of not more than 5 ohms. Ground rods shall be tested individually prior to connection to the system and the system as a whole shall be tested not less than 48 hours after rainfall. When the resistance of the complete installation exceeds the specified value or two ground rods individually exceed 5 ohms, the Contracting Officer will be notified immediately. A counterpoise, where required, shall be of No. 1/0 copper cable or equivalent material having suitable resistance to corrosion and shall be laid around the perimeter of the structure in a trench not less than 2 feet deep at a distance not less than 3 feet nor more than 8 feet from the nearest point of the structure. All connections between ground connectors and grounds or counterpoise, and between counterpoise and grounds shall be electrically continuous. Where so indicated on the drawings, an alternate method for grounding electrodes in shallow soil shall be provided by digging trenches radially from the building. The lower ends of the down conductors are then buried in the trenches.

3.2 FENCES

Except as indicated below, metal fences that are electrically continuous with metal posts extending at least 2 feet into the ground require no additional grounding. Other fences shall be grounded on each side of every gate. Fences shall be grounded by means of ground rods every 1000 to 1500 feet of length when fences are located in isolated places, and every 500 to 750 feet when in proximity (100 feet or less) to public roads, highways, and buildings. Where the fence consists of wooden posts and horizontal metal strands only, down conductors consisting of No. 8 copper wire or equivalent shall be run from the ground rod the full height of the fence and fastened to each wire, so as to be electrically continuous. The connection to ground shall be made from the post where it is of metal and is electrically continuous with the fencing. All metal fences shall be grounded at or near points crossed by overhead lines in excess of 600 volts and at distances not exceeding 150 feet on each side of line crossings.

3.3 INSPECTION

The lightning protection system will be inspected by the Contracting Officer to determine conformance with the requirements of this specification. No part of the system shall be concealed until so authorized by the Contracting Officer.

End of Section